Modelación de díadas de emociones a través del análisis de sentimientos

Modelling dyads of emotions via sentiment analysis

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Resumen

Este artículo presenta una nueva metodología para cuantificar la probabilidad y magnitud de combinaciones de emociones -denominadas díadas- a través del análisis de sentimientos el cual proporciona probabilidades a priori de las emociones básicas, necesarias para mostrar la presencia de díadas en perfiles de personas. Clasificamos estas características -probabilidad y magnitud- de las díadas en seis grupos (máximo, muy alto, alto, medio, bajo, muy bajo) con el fin de identificar las emociones que tienen más impacto en lo que, en este trabajo, llamamos perfiles positivos, negativos, neutros y combinados. Los perfiles positivos presentan principalmente Amor, mientras que los perfiles negativos presentan Desprecio y Arrepentimiento. En general, la magnitud de las díadas primarias es mayor que su probabilidad, no así en el caso de las díadas secundarias y terciarias, donde su probabilidad es mayor que su magnitud.

Palabras clave: Emociones; Díadas; Análisis de los sentimientos

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Abstract

This article presents a new methodology to quantify the probability and magnitude of combinations of emotions -called dyads- through a sentiment analysis which provides prior probabilities of the basic emotions, needed to show the presence of dyads in profiles of people. We classify these features -probability and magnitude- of the dyads into six groups (max, very high, high, medium, low, lowest) in order to identify emotions that have more impact in what we call in this work: positive, negative, neutral, and combined profiles. Positive profiles present mainly Love, while negative profiles present Contempt and Regret. In general, the magnitude of the primary dyads is greater than their probability, not so with the secondary and tertiary dyads where their probability is greater than their magnitude.

Keywords: Emotions; Dyads; Sentiment analysis.

Introduction

The crisis caused by the COVID-19 pandemic, in addition to being a public health crisis has had an impact on the economy, the social activities, the way of interacting, the change in lifestyles due to lock-down, the closure of schools in a face-to-face mode, etc. All these facts are concerning, as there is the possibility that they may trigger problems of mental health that could escalate, even to suicide.

Emotion is a topic of study in psychology, philosophy, sociology, neuroscience, and more recently, artificial intelligence. Due to the topic is approached from multiple fields, its study is extensive, from emotional responses of facial expressions to different types of subjective experiences of an individual's state of mind (Liu, 2012).

It is well known that human emotions are complex, and words often convey affect, that is, emotions, feelings, and attitudes. However, some relevant literature has shown studies about detection of emotions based on text analysis, Mohammad and Kiritchenko (2018) used Twitter for analyzing the intensity of emotions, considering supervised machine learning algorithms for multi-label emotion classification.

Using the social network Twitter (or Facebook) for getting textual data is convenient since tweets are self-contained, widely used, posts are available, and tend to be rich in emotions. It is also very common to use the statistical package R, through the NRC-Emotion Lexicon; it was created by crowdsourcing and includes entries for about 14,000 words and the eight basic Plutchik emotions (see Mohammad and Turney (2010), Mohammad and Turney (2013)).

Mohammad (2017) presented a manually created *affect intensity lexicon* (NRC Affect Intensity Lexicon, AIL) with real-valued scores of intensities for four basic emotions: anger, fear, joy, and sadness. However, it is common to study the basic emotions classified into positive (Joy and Confidence), negative (Sadness, Anger, Fear, and Aversion), and neutral (Surprise and Anticipation).

Experts say that basic emotions are usually presented in combination, that is, in a more complex form, and they rarely manifest alone. The combination of basic emotions is called dyad. Intensity or magnitude is a factor that distinguishes an emotion (or dyad) from another, it refers to the force with which an emotion is experienced. Primary dyads

are those which people feel frequently, secondary dyads refer to those felt sometimes, and tertiary dyads to those rarely felt.

However, another important feature of an emotion, or a dyad, is the probability of having it. Using R and the NRC Emotion Lexicon, we can get the probability of having a basic emotion (called in this paper as prior probability), but until now, there is not a methodology to get the probability of having a dyad.

Plutchik (1989) has proposed a methodology of measuring emotions and their derivatives, but some interesting questions may arise:

(1)   Having a prior distribution of some basic emotions, which are the probabilities and magnitudes of getting dyads of emotions?

(2)   How can we classify profiles of people according to the probabilities and magnitudes of their dyads?

(3)   Which dyads appear in profiles of people with emotions mainly positive, negative, and neutral?

Modelling emotions have become a very interesting area mainly for statisticians and psychologists. Using sentiment analysis, we can quantify the percentage of the emotions that people have, using the text they have written. Certainly, it is very common to use the social media platform Twitter (Rodríguez-Esparza, Barraza-Barraza, Salazar-Ibarra, and Vargas-Pasaye, 2019) in order to analyze the basic emotions (Joy, Confidence, Fear, Surprise, Sadness, Disgust/Aversion, Anger, and Anticipation- see Plutchik (1994)).

The succeeding parts of the paper are organized as follows. In Section 2, we provide some background on the field of emotions and sentiment analysis. Section 3 provides the methodology to calculate probabilities and magnitudes of getting dyads. In Section 4 we consider some profiles of people: positive, negative, neutral, and combined, in order to identify the mainly dyads presented in each profile. Finally, some conclusions are given in Section 5.

1. Background

The psychoevolutionary theory of emotions written by Plutchik (2001), postulates that emotions play an adaptive role in helping organisms to deal with key survival issues raised by the environment. For example, anger and fear are very primitive in human

behavior and their function is to be prepared to pay attention (see Hochschild (1979), Plutchik (1994), Plutchik (2001)). Our emotions are also biologically linked with the senses, they help to understand our relationship with the senses of others and are essential for socialization (Hochschild, 1979).

Plutchik (2001) drew a wheel of emotions (see Figure 1), which consisted of eight basic emotions: 1. Joy, 2. Trust/confidence, 3. Fear, 4. Surprise, 5. Sadness, 6. Disgust/aversion, 7. Anger, and 8. Anticipation. Through the combination of them we get eight advanced emotions: love, submission, fright, disapproval, regret, contempt, aggressiveness, and optimism; these will be identified as *Primary dyads* (see Table 1). Moreover, basic emotions are combined with their neighbors, which will be named as *Secondary* and *Tertiary dyads,* which result in even less frequent emotions (see also Table 1). Also note that we can identify the opposite emotions, for example, the opposite of anticipation is surprise, the opposite of aversion is confidence, and so on.

Figure 1

Plutchik's wheel of emotions.
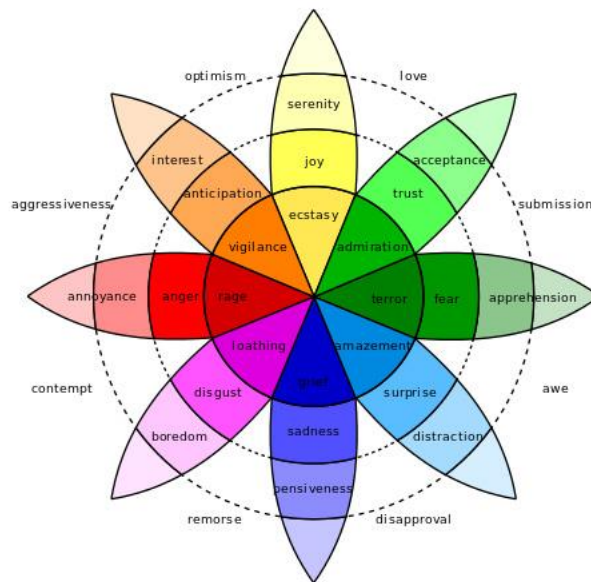
Source: From Plutchik (2001).

Table 1

Dyads of emotions given by Plutchik.

Primary dyads	Secondary dyads	Tertiary dyads
Joy+Confidence=Love	Joy+Fear=Guilt	Joy+Surprise=Delight
Confidence+Fear=Submissio	Confidence+Surprise=Curio	Confidence+Sadness=Sentim
Fear+Surprise=Fright	Fear+Sadness=Desperation	Fear +
Surprise+Sadness=Disapprov	Surprise+Aversion=Disbelie	Surprise+Anger=Outrage
Sadness+Aversion=Regret	Sadness+ Anger=Envy	Sadness+Anticipation=Pessi
Aversion+Anger=Contempt	Aversion+Anticipation=Cyn	Aversion+Joy=Curiosity
Anger Anticipation	Anger+Joy=Pride	Anger+Confidence=Dominati
Anticipation+Joy=Optimism	Anticipation+Confidence=F	Anticipation+Fear=Anxiety

Source: From Plutchik (2001).

Emotions can be divided into positive, negative, and neutral. Positive emotions, like joy, increase physical, social, and intellectual human resources, and also build emotional reserves in the face of a challenge. Negative emotions, like fear, sadness, or anger, are natural defenses against external threats. Therefore, emotions govern human thought patterns, beliefs, behaviors, attitudes, and responses to life experiences (Ponce and Cordelier, 2019).

Until know, there is not a methodology to calculate the dyads. Therefore, the main purpose of this paper is to find the probability and magnitude of having combinations of basic emotions. One path of analyzing these measurements is through data mining. Hence, in the following section we introduce the technicalities of sentiment analysis.

1.1. Sentiment analysis

Sentiment analysis or opinion mining is an area of research that aims to the computational treatment of opinions, feelings, and subjectivity in texts; it arises as a way to identify the opinions and trends that people follow on social networks, blogs, or web pages (Raya-Ríos, 2017). The aim of sentiment analysis is diverse, it covers topics that go from opinions about products, movies or services, to social-cultural interest such as: elections, wars, or soccer, among others.

Bing Liu (2012) defines it as follows: "Sentiment analysis, also called opinion mining, is the field of study that analyzes people's opinions, sentiments, evaluations, appraisals, attitudes, and emotions towards entities such as products, services, organizations, individuals, issues, events, topics, and their attributes". According to the task in charge, we can find this analysis with different names: sentiment analysis, opinion mining, opinion extraction, sentiment mining, subjectivity analysis, affect analysis, emotion analysis, review mining, etc.

Messages on social media are usually short and lack of explicit sentiment words, therefore, Liu, Tang, Sun, Chen, Cao, Luo and Zhao (2020) proposed a model for performing context-aware user sentiment analysis, using a Twitter dataset. Dang, Moreno-García and De la Prieta (2020) employed deep learning to solve sentiment analysis problems, such as sentiment polarity, the authors also give a comparative study using different models and input features.

In the last decade, there have been interesting studies about sentiment and emotion analysis considering different fields of research. Barron-Estrada, Zatarain-Cabada and Bustillos (2019) presented a sentiment analyzer for the recognition of emotions centered on learning using textual phrases of students. Using tracking mode methods, Nahar, Sultana, Iqbal and Chowdhury (2019) used sentiment analysis to extract emotions from textual contents (micro-blogging).

Until now, most systems detect basic emotions and most research focusses on recognizing polarities of sentiments (positive and negative), however, it is important to also detect combinations of emotions. Therefore, in this work we present a methodology for this last purpose.

2. Methodology

In this section, we provide a novel methodology to calculate the probabilities and magnitudes of getting dyads.

2.1. Prior probability of the emotions

Once we obtain the text of the people, i.e., their tweets, we need to do a sentiment analysis using the library "syuzhet" of the statistical package R, and the function get nrc sentiment, to associate the words of the text with the eight primary emotions. Therefore, we can get the probability of each basic emotion p_i, $i \in \{1, \dots, 8\}$ by normalizing this information, i.e., dividing the number of words obtained in the emotion i by the total amount of words in all emotions.

2.2. Construction of dyads

To calculate the probabilities and the magnitudes of the dyads, we need to do the following. Let fix a basic emotion i, as before, using sentiment analysis we obtain p_i (the prior probability of the emotion i, for $i \in \{1, \dots, 8\}$).
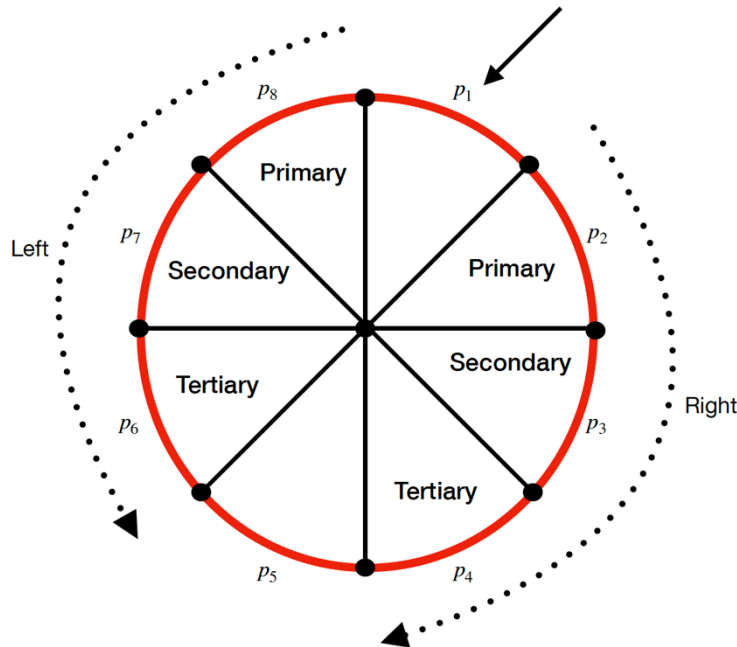
Probability of the dyads

1. Find the prior probabilities of the neighbors of emotion i.

Let p_{ijk} be the prior probability of the j-th neighbor emotion of i, for $j \in \{1, 2, 3\}$, $j = 1$ denotes the primary dyads, $j = 2$ secondary dyads, and $j = 3$ tertiary dyads, and considering the direction $k \in \{R, L\}$, here R means the neighbors' emotions on the right of i, and L the neighbors' emotions on the left side of i. See Figure 2.

Figure 2

Example of the construction of the dyads. If we consider $i = 1$, i.e., Joy, then on a clockwise direction we construct the dyads: primary (Love), secondary (Guilt) and tertiary (Delight). Additionally, on a counterwise direction, we get the dyads: primary (Optimism), secondary (Pride) and tertiary (Curiosity).

Source: Own elaboration.

2. Calculate the probability of the dyads.

We consider the basic emotion has the same probability (0.5) of going to its right ($k = R$) or going to its left ($k = L$). Fixing k (the direction), we can define: Ecuación

$$D_{i1k} = \min\{p_i, p_{i1k}\}.$$
$$D_{i2k} = \max\{0, \min\{p_i - p_{i1k}, p_{i2k}\}\}.$$
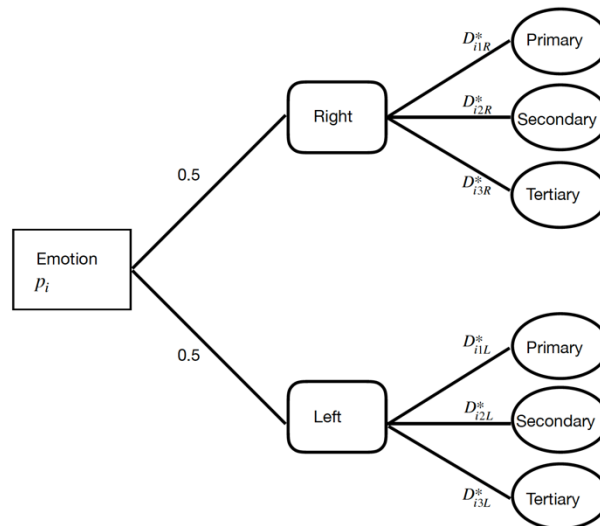$$D_{i3k} = \max\{0, \min\{p_i - p_{i1k} - p_{i2k}, p_{i3k}\}\}.$$

Let P_{ijk} denote the probability of the dyad j, $j \in \{1,2,3\}$ for $k \in \{R, L\}$, associated with the emotion i. This probability is given by Ecuación

$$P_{ijk} = 0.5 D_{ijk}^*, \tag{1}$$

where $D_{ijk}^* = \frac{D_{ijk}}{\sum_{s=1}^{3} D_{isk}}, j \in \{1,2,3\}$, i.e., $\sum_{j=1}^{3} D_{ijR}^* = 1$ and $\sum_{j=1}^{3} D_{ijL}^* = 1$. See the decision tree given in Figure 3. Note that $\sum_{j=1}^{3} \sum_{k \in \{R,L\}} P_{ijk} = 1$, for all i.

Figure 3.

Decision tree for calculating the probabilities of the dyads.

Source: Own elaboration.

Magnitude of the dyads

Once the probabilities of presenting dyads have been calculated, the most logical thing would be to calculate the magnitude with which they could occur. As an example, let us say that "aggressiveness" was obtained, but it could be present at a very low level, which would not be significant; conversely, at a high level, it would indicate that you must pay attention. This leads to the need to calculate its magnitude and not just limit itself to probability.

For $i \in \{1,2,\ldots,8\}$ and $k \in \{R, L\}$, as it was mentioned before, there is a probability of 0.5 of considering the right side of the emotions and 0.5 for the left, therefore we propose the weights of the dyads as follows: $W_{i1k} = 0.30$ (primary dyads -frequently felt), $W_{i2k} = 0.15$ (secondary dyads -sometimes felt), and $W_{i3k} = 0.05$ (tertiary dyads - rarely felt). These weights are arbitrary, but with the assumption that all weights must sum up to 0.5.

The magnitude of the dyads for $i \in \{1,2,\ldots,8\}$, $j \in \{1,2,3\}$, $k \in \{R, L\}$ is given by

$$M_{ijk} = \frac{D_{ijk}^* \cdot W_{ijk}}{\sum_s D_{ijs}^* \cdot W_{ijs}}. \tag{2}$$

Satisfying $\sum_{j=1}^{3} \sum_{k \in \{R,L\}} M_{ijk} = 1$, for all i.

Note that if a probability P_{ijk} is 0 then the magnitude M_{ijk} is also 0.

2.3. Classification

Classification is a widely used statistical tool to characterize objects or people by groups. The elements within the same group (cluster) share similar characteristics, while their features are different between groups. In opinion mining, classification is also very important, since it will be possible to identify profiles of people who have high probability and magnitude in such a way that they influence the analysis.

In order to classify the probability and magnitude of the dyads, we have proposed to divide them into six groups (see Table 2).

Table 2

Classification for the probability and magnitude of dyads.

| Interval	Classification
[0.0, 0.2)	Lowest
[0.2, 0.3)	Low
[0.3, 0.5)	Medium
[0.5, 0.7)	High
[0.7, 0.8)	Very High
[0.8, 1.0]	Max

Source: Own elaboration.

We will say that dyads with levels Max, Very High, and High probability and magnitude have more impact on the decision of the profiles, and dyads with levels Medium, Low, and Lowest have less impact on the decision of the profiles.

Figure 4 shows a way of reading the results of the probabilities and magnitudes of the dyads according to their classification. For example, "*With High probability and Medium magnitude, I feel Optimism*". The probability and magnitude are quantitative data, while the dyad is a qualitative data.

Figure 4

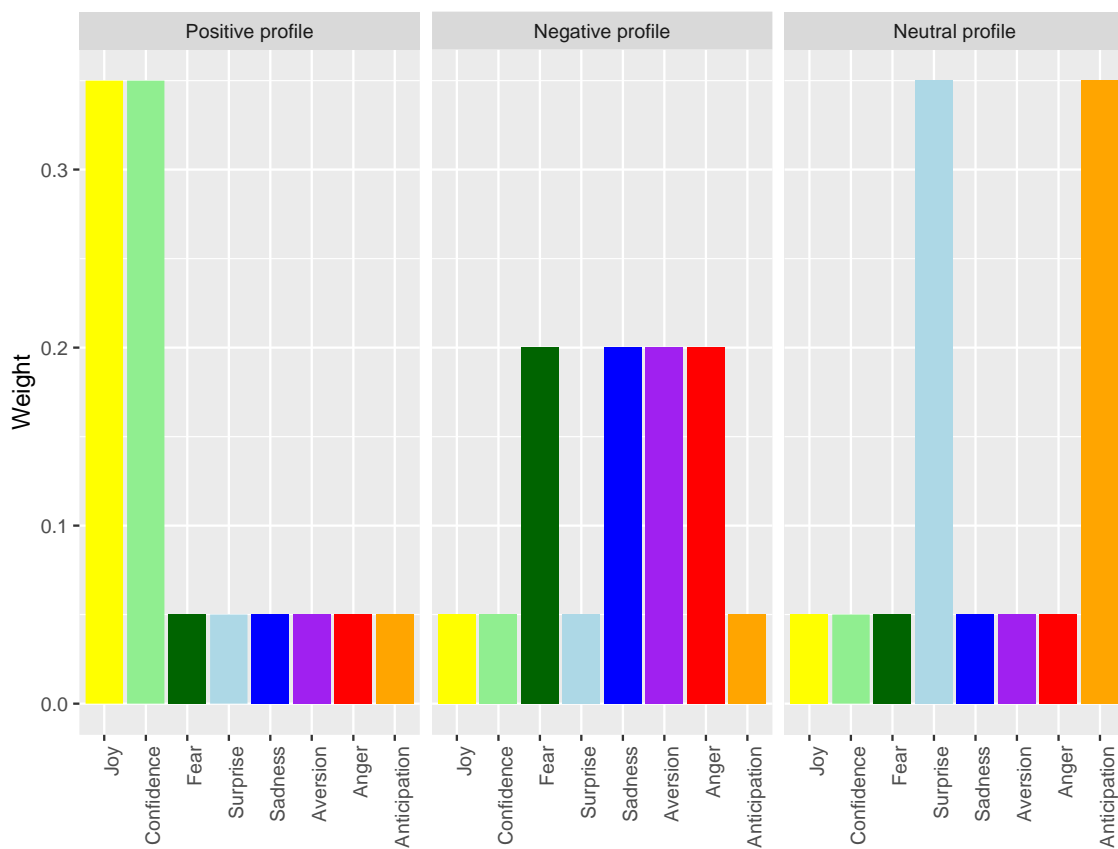*Reading the results of the probabilities and magnitudes of the dyads.*
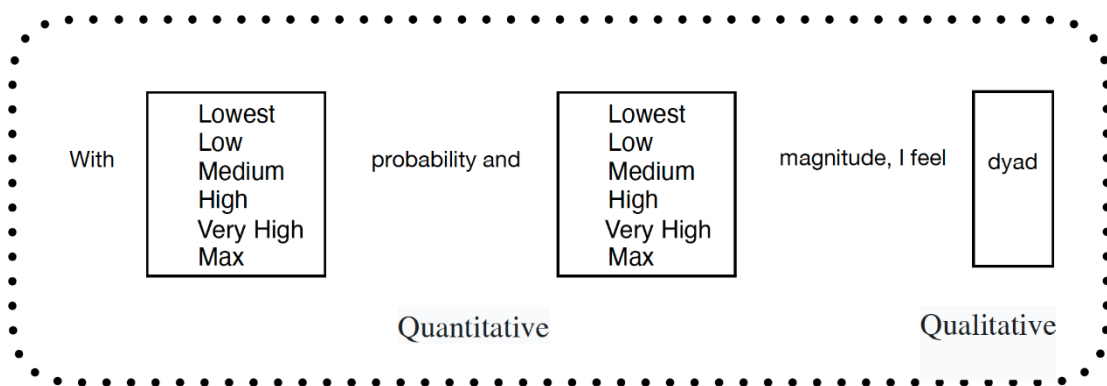
Source: Own elaboration.

3. Results

Let consider three types of people profile: the first one, having major probability of the positive basic emotions -called *Positive profile*-, the second, having more probability of the negative basic emotions -called *Negative profile*-, and the third one, having more probability of the neutral basic emotions -called *Neutral profile*- (see Figure 5).

Figure 5

Example of Positive, Negative, and Neutral profiles.

Source: Own elaboration.

Table 3 exhibits the results of the probabilities and magnitudes (including their classification) of the obtained dyads considering the *Positive profile*. Throughout the paper, the results of dyads having probability and magnitude equals to 0 are omitted.

Table 3

Results of the Positive profile.

Basic Emotion	p_i	Dyad	Emotion	Probability	Magnitude	Classification Probability	Classification Magnitude
Joy	0.35	Primary	Love	0.7	0.875	Very High	Max
Joy	0.35	Primary	Optimism	0.1	0.075	Lowest	Lowest
Joy	0.35	Secondary	Pride	0.1	0.0375	Lowest	Lowest
Joy	0.35	Tertiary	Curiosity	0.1	0.0125	Lowest	Lowest
Confidence	0.35	Primary	Submission	0.1	0.075	Lowest	Lowest
Confidence	0.35	Primary	Love	0.7	0.875	Very High	Max
Confidence	0.35	Secondary	Curiosity	0.1	0.0375	Lowest	Lowest
Confidence	0.35	Tertiary	Sentimentality	0.1	0.0125	Lowest	Lowest

Source: Own elaboration.

For this *Positive profile*, *Love* is surely a dyad that has high probability and magnitude. *Optimism* and *Submission* are dyads that can appear with medium probability and magnitude. Other dyads that can appear, but with low probability and magnitude, are *Pride*, *Curiosity*, and *Sentimentality*.

Table 4 shows the results of the probabilities and magnitudes (including their classification) of the obtained dyads considering the *Negative profile*.

Table 4

Results of the Negative profile.

Basic Emotion	p_i	Dyad	Emotion	Probability	Magnitude	Classification Probability	Classification Magnitude
Fear	0.2	Primary	Fright	0.1429	0.2692	Lowest	Low
Fear	0.2	Primary	Submission	0.1429	0.2308	Lowest	Low
Fear	0.2	Secondary	Desperation	0.4286	0.3462	Medium	Medium
Fear	0.2	Secondary	Guilt	0.1429	0.1154	Lowest	Lowest
Fear	0.2	Tertiary	Anxiety	0.1429	0.0385	Lowest	Lowest
Sadness	0.2	Primary	Regret	0.5	0.7143	High	Very High
Sadness	0.2	Primary	Disapproval	0.125	0.125	Lowest	Lowest
Sadness	0.2	Secondary	Desperation	0.375	0.1607	Medium	Lowest
Aversion	0.2	Primary	Contempt	0.5	0.5	High	High

Aversion	0.2	Primary	Regret	0.5	0.5	High	High
Anger	0.2	Primary	Aggressiveness	0.1429	0.12	Lowest	Lowest
Anger	0.2	Primary	Contempt	0.5714	0.8	High	Max
Anger	0.2	Secondary	Pride	0.1429	0.06	Lowest	Lowest
Anger	0.2	Tertiary	Domination	0.1429	0.02	Lowest	Lowest

Source: Own elaboration.

For this *Negative profile*, *Contempt* and *Regret* are surely dyads that have high probability and magnitude. *Desperation* is a dyad with medium probability and magnitude. Other dyads that can appear, but with low probability and magnitude, are: *Fright, Sub-mission, Guilt, Anxiety, Disapproval, Aggressiveness, Pride,* and *Domination.*

Table 5 has the results of the probabilities and magnitudes (including their classification) of the obtained dyads considering the *Neutral profile*.

Table 5

Results of the Neutral profile.

Basic Emotion	p_i	Dyad	Emotion	Probability	Magnitude	Classification Probability	Classification Magnitude
Surprise	0.35	Primary	Disapproval	0.1667	0.3	Lowest	Medium
Surprise	0.35	Primary	Fright	0.1667	0.3	Lowest	Medium
Surprise	0.35	Secondary	Disbelief	0.1667	0.15	Lowest	Lowest
Surprise	0.35	Secondary	Curiosity	0.1667	0.15	Lowest	Lowest
Surprise	0.35	Tertiary	Outrage	0.1667	0.05	Lowest	Lowest
Surprise	0.35	Tertiary	Delight	0.1667	0.05	Lowest	Lowest
Anticipation	0.35	Primary	Optimism	0.1667	0.3	Lowest	Medium
Anticipation	0.35	Primary	Aggressiveness	0.1667	0.3	Lowest	Medium
Anticipation	0.35	Secondary	Fatalism	0.1667	0.15	Lowest	Lowest
Anticipation	0.35	Secondary	Cynicism	0.1667	0.15	Lowest	Lowest
Anticipation	0.35	Tertiary	Anxiety	0.1667	0.05	Lowest	Lowest
Anticipation	0.35	Tertiary	Pessimism	0.1667	0.05	Lowest	Lowest

Source: Own elaboration.

For the *Neutral profile* we identify that the dyads: *Disbelief, Curiosity, Fatalism, Cynicism, Outrage, Optimism, Anxiety,* and *Pessimism* have both Lowest probability and magnitude, except for *Disapproval, Fright, Optimism*, and *Aggressiveness* that have Medium magnitude.

3.1. Combined profile

As another example, let consider a random person from Twitter called in this work as *Combined profile*, where his/her last 1000 tweets have been analyzed, and the language used was Spanish. Figure 6 shows the analysis of his/her tweets in groups of one hundred at a time. For each group of data, we obtained the prior probability of each basic emotion.

Prediction is a widely used resource in modeling and specifically in opinion analysis to identify the behavior of a phenomena or, in this case, emotions of people, in the future. For example, in terms of sales, it is important to know the emotional state of customers to release a product to the market.

Since the sum of all the prior probabilities is 1, we can consider the vector $(p_1, p_2, \cdots, p_8)$, as a compositional vector. Therefore, we can predict his/her next prior probabilities via a compositional analysis. Using a hyperspherical transformation (we recommend Wang, Lu, Mok, Fu and Tse (2007) to see the details of this transformation), we predicted his/her 500 next tweets -denoted in Figure 6 by P1, P2, . . . , P5- in order to see the behavior (emotions) of this profile in the future.

Figure 6

Combined profile: 1000 tweets, in groups of one hundred at a time. *Prediction using compositional data.*
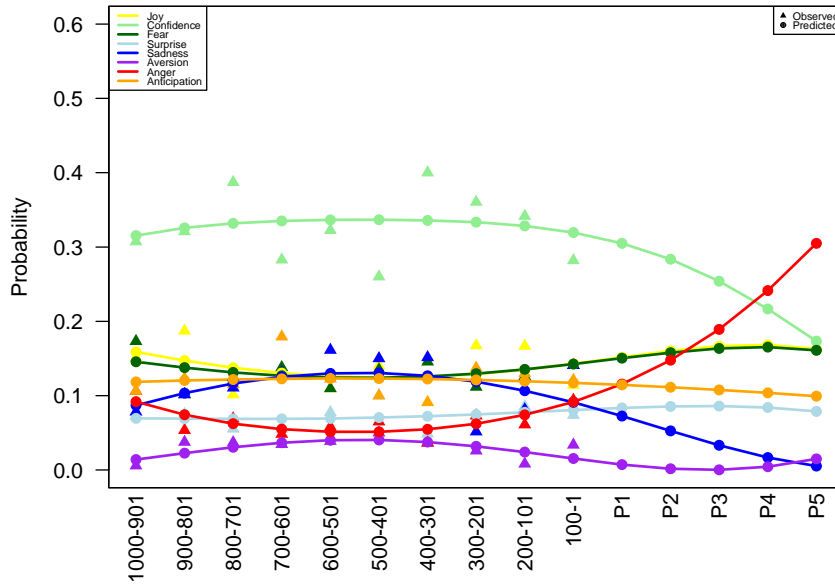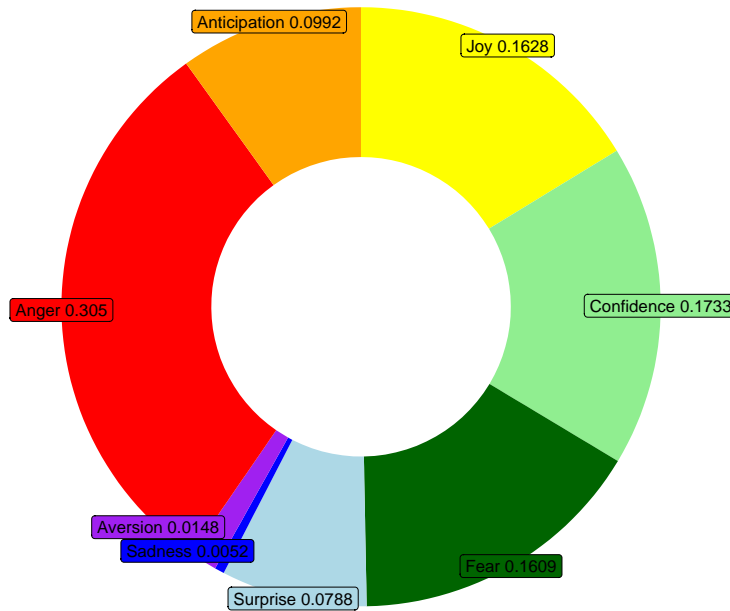

Source: Own elaboration.

Figure 6 shows that, mainly, his/her Confidence and Sadness are getting low, while his/her Anger is increasing (see Figure 7). The other basic emotions remain almost with the same prior probabilities.

Figure 7

Prior probabilities of the basic emotions of Combined profile obtained from the prediction P5.

Source: Own elaboration.

Sadness and Aversion are the emotions with the lowest prior probability. These emotions are classified as negative. Also note that these emotions are neighbors, with opposite emotions Joy and Confidence, respectively. Then, he/she has Surprise and Anticipation. This is quite interesting since both are opposites and are considered as neutral emotions. Surprise is considered by some theorists to be one of the emotions that have a universal pattern of facial expression. The physiological response includes raising or arching the eyebrows, opening the eyes wide, opening the mouth wide in an oval shape, and gasping. Fear, Joy, and Confidence have almost the same prior probability. These emotions are neighbors. The dyads from these emotions are expected to have high probability. And finally, Anger is the basic emotion with the highest prior probability. Remember that is a negative emotion.

In Table 6 we present the resulting dyads of the *Combined profile*.

Table 6

Results of the dyads of the Combined profile.

Basic Emotion	p_i	Dyad	Emotion	Pro-babi-lity	Magni-tude	Classifica-tion Probability	Classifica-tion Magnitude
Fear	0.1609	Primary	Fright	0.3034	0.2238	Medium	Low
Fear	0.1609	Primary	Submission	0.6196	0.7618	High	Very High
Fear	0.1609	Secondary	Desperation	0.02	0.0074	Lowest	Lowest
Fear	0.1609	Tertiary	Embarrass-ment	0.057	0.007	Lowest	Lowest
Joy	0.1628	Primary	Love	0.5	0.6478	Medium	High
Joy	0.1628	Primary	Optimism	0.3047	0.2763	Medium	Low
Joy	0.1628	Secondary	Pride	0.1953	0.0759	Lowest	Lowest
Confidence	0.1733	Primary	Submission	0.4642	0.4824	Medium	Medium
Confidence	0.1733	Primary	Love	0.4697	0.4881	Medium	Medium
Confidence	0.1733	Secondary	Curiosity	0.0358	0.0159	Lowest	Lowest
Confidence	0.1733	Secondary	Fatalism	0.0303	0.0135	Lowest	Lowest
Anger	0.305	Primary	Aggressive-ness	0.2457	0.4544	Low	Medium
Anger	0.305	Primary	Contempt	0.0367	0.0678	Lowest	Lowest
Anger	0.305	Secondary	Pride	0.4032	0.3729	Medium	Medium
Anger	0.305	Secondary	Envy	0.0129	0.0119	Lowest	Lowest
Anger	0.305	Tertiary	Domination	0.1065	0.0328	Lowest	Lowest
Anger	0.305	Tertiary	Outrage	0.1951	0.0602	Lowest	Lowest

Source: Own elaboration.

In ordering Table 6 according to the variable Probability, we can see that Submission (Confidence+Fear) is in the first place. Submission means compliance with or surrender to the requests, demands, or will of others. Note that if we have a prior probability of fear 0.1609, then we will have Submission with a probability 0.6196 and magnitude 0.7618, On the other hand, if we have a prior probability of Confidence of 0.1733, then we will have Submission with probability 0.4697 and magnitude 0.4824.

The second place dyad is Love (Joy+Confidence). Love is an emotion that involves feelings of affection for the object of love, including pleasurable sensations of it. Pride (Anger+Joy) is a self-conscious emotion that occurs when a goal has been attained and one's achievement has been recognized and approved by others. Having Anger with a prior probability 0.3050, will lead to having Pride with probability 0.4032 and magnitude 0.3729. However, having Joy with prior probability 0.1628, will lead to having Pride with probability 0.1953 and magnitude 0.0759.

Then we have Optimism (Anticipation+Joy), which is the attitude that good things will happen, and that people's wishes will ultimately be fulfilled. Fright (Fear+Surprise) is the emotional reaction that arises in the face of a dangerous or potentially dangerous situation or encounter. Having the emotion Fear with a prior probability of 0.1609 will lead to having Fright with probability 0.3034 and magnitude 0.2238.

Aggressiveness (Anger+Anticipation) is a tendency toward social dominance, threatening behavior, and hostility. It may occur sporadically or be a characteristic trait of an individual.

From Table 6 we can say that the *Combined profile* has:

- With High probability and Very High magnitude, he/she is feeling Submission.
- With High probability and High magnitude, he/she is feeling Love.
- With Medium probability and Medium magnitude, he/she is feeling Submission, Love, and Pride.
- With Medium probability and Low magnitude, he/she is feeling Fright, and Optimism.
- With Low probability and Medium magnitude, he/she is feeling Aggressiveness.
- With Lowest probability and Lowest magnitude, he/she is feeling Desperation, Embarrassment, Pride, Curiosity, Fatalism, Domination, Contempt, Envy, and Outrage.

A very important point here is the following. Note that Anger has a very high prior probability, but its neighbors have very low prior probabilities, this means that Aggressiveness and Contempt (primary dyads) do not have high probabilities.

A summary of different profiles are presented in Table 7.

Table 7

Dyads of positive, negative, neutral, and combined profiles.

| Profile	Max/Very High	High/Medium	Low/Lowest
Positive	Love	Optimism, Submission	Pride, Curiosity, Sentimentality
Negative	Contempt and Regret	Desperation, Fright, Submission, Disapproval, Aggressiveness	Guilt, Anxiety, Pride, and Domination
Neutral		Fright, Disapproval, Aggressiveness, Optimism	Cynicism, Outrage, Optimism, Anxiety, and Pessimism
Combined	Submission	Love, Pride, Fright, Optimism	Aggressiveness, Desperation, Embarrassment, Pride, Curiosity, Fatalism, Domination, Contempt, Envy, Outrage

Source: Own elaboration.

3.2. Confidence intervals

In order to see the range of values we expect the probability and the magnitude of the primary, secondary and tertiary dyads fall, we calculate its confidence intervals, which is the mean of our estimation (probability or magnitude) plus and minus the variation in that estimate.

We consider a random sample of 150 Twitter users and we analyze 1000 tweets (in Spanish) of each of them. We calculate the 95% confidence intervals of the features of the dyads; the results are presented in Figure 8. The way of construction the probability and the magnitude were 50-50, i.e., fixing a basic emotion, it has 50% of chance of constructing its dyads over its right and 50% over its left, therefore the values of Figure 8 are up to 0.5.

Figure 8

Confidence intervals of the probability and magnitude of the primary, secondary, and tertiary dyads.
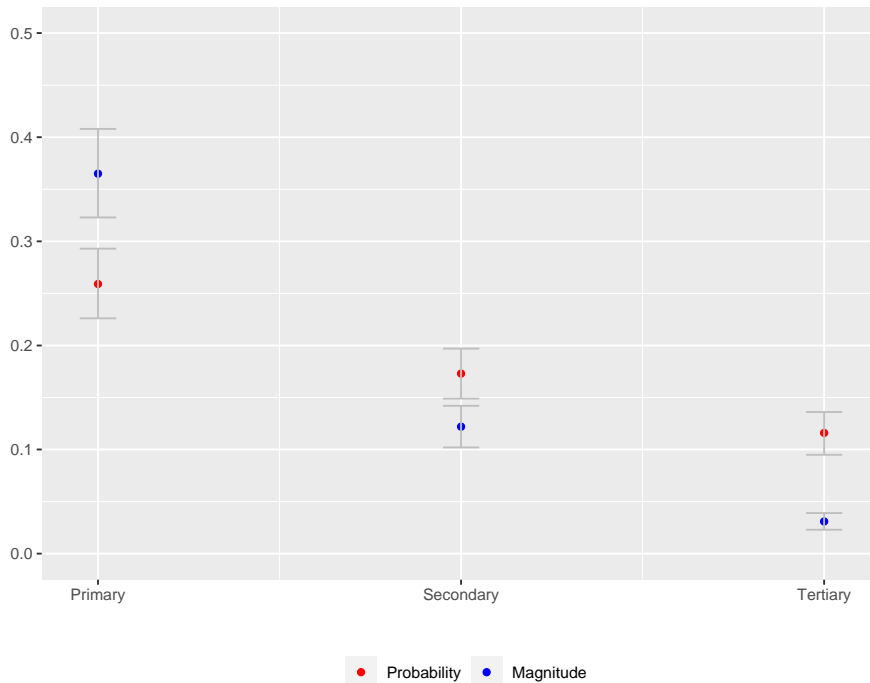
Source: Own elaboration.

As we can see in Figure 8, the mean of the probabilities for the primary, secondary, and tertiary dyads were 0.259, 0.173, and 0.116, respectively. While the mean of the magnitudes for the primary, secondary and tertiary dyads were 0.365, 0.122, and 0.031, respectively. Only in the primary dyad we see that the probability is lower than its magnitude.

4. Conclusions

We have provided a novel methodology to calculate two important features on the construction of dyads: probability and magnitude. We have included some classifications techniques in order to identify profiles of people having more positive, negative and neutral emotions.

We have used sentiment analysis as a tool to find these quantitative characteristics of the dyads. We used the statistical program R, and its library syuzhet through the function *get nrc sentiment* to obtain the prior probabilities of the basic emotions, needed to find the probabilities of the dyads.

As expected, the *Positive profile* has presented mainly Love, while the *Negative profile* presented Contempt and Regret.

One important point is the following. It is well known that the primary dyads are those frequently presented in people; however, those can be presented with low probability and magnitude, as showed in the *Neutral profile*.

The *Combined profile* has shown very important results. We can think that if a profile has very high prior probability on a negative basic emotion, then he/she will experience negative dyads. We showed that this case will not happen unless the neighbors of the negative basic emotion have considerable (high) prior probabilities. Indeed, the *Combined profile* has mainly Submission contrary dyad to Contempt, which is a dyad presented in the *Negative profile*. However, Submission has important positive and negative interpretations.

Finally, in general, we obtained that the magnitude of the primary dyads is greater than their probability, not so with the secondary and tertiary dyads where their probability is greater than their magnitude.

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