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Applying a culture dependent emotion triggers database for text valence and emotion classification

Definición de disparador de emoción asociado a la cultura y aplicación a la clasificación de la valencia y la emoción en textos

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Resumen: Este artículo presenta un método de identificación y clasificación de la valencia y las emociones presentes en un texto. Para ello, se introduce un nuevo concepto denominado disparador de emoción. Inicialmente, se construye de forma incremental una base de datos léxica de disparadores de emoción asociados a la cultura con la que se quiere trabajar, basándose en tres teorías diferentes: la Teoría de la Relevancia de Pragmática, la Teoría de la Motivación de Maslow de Psicología y la Teoría de Necesidades de Neef de Economía. La base de datos creada parte de un conjunto inicial de términos y es ampliada con la información de otros recursos léxicos, como WordNet, NomLex y dominios relevantes. El enlace entre idiomas se hace por medio de EuroWordNet y se completa y adapta a diversas culturas con bases de conocimiento específicas para cada lengua. También, se demuestra cómo la base de datos construida puede ser utilizada para buscar en textos la valencia (polaridad) y el significado afectivo. Finalmente, se evalúa el método utilizando los datos de prueba de la tarea nº 14 de Semeval "Texto afectivo" y su traducción al español. Los resultados y las mejoras se presentan junto con una discusión en la que se tratan los puntos fuertes y débiles del método y las directrices para el trabajo futuro.

Palabras clave: disparador de emoción, base de datos léxica, teoría de la relevancia, motivación, modelo cognitivo de construcción e integración

Abstract: This paper presents a method to automatically spot and classify the valence and emotions present in written text, based on a concept we introduced - of emotion triggers. The first step consists of incrementally building a culture dependent lexical database of emotion triggers, emerging from the theory of relevance from pragmatics, Maslow´s theory of human needs from psychology and Neef´s theory of human needs in economics. We start from a core of terms and expand them using lexical resources such as WordNet, completed by NomLex, sense number disambiguated using the Relevant Domains concept. The mapping among languages is accomplished using EuroWordNet and the completion and projection to different cultures is done through language-specific commonsense knowledge bases. Subsequently, we show the manner in which the constructed database can be used to mine texts for valence (polarity) and affective meaning. An evaluation is performed on the Semeval Task No. 14: Affective Text test data and their corresponding translation to Spanish. The results and improvements are presented together with an argument on the strong and weak points of the method and the directions for future work.

Keywords: emotion trigger, lexical database, theory of relevance, human motivation, construction and integration cognitive model

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1 Introduction

In recent years, there has been growing interest in studying the methods through which emotion is expressed in written text. Whether it is mining for customer opinions, or tracing attitudes towards different topics of interest, tools and applications aiming at discovering sentiment, spotting and, moreover, interpreting emotion in text is highly applicable to various natural language processing areas. Some important examples include word sense disambiguation (Wiebe and Mihalcea, 2006), multi-document summarization, multi-perspective question answering and speech generation.

Present work in the field focused on determining methods to capture emotion and opinion arising from written text, at a word level – identifying positive or negatve sentiment of words (Esuli and Sebastiani, 2005), sentence or phrase level (Kim and Hovy, 2006), document level (Hu and Liu, 2004). Lexical resources born from these endowments are WordNet Affect (Strapparava and Valitutti, 2004) and SentiWordNet (Esuli and Sebastiani, 2006), both for English. Lexical databases were in turn completed in several approaches toward sentiment analysis with lexical and commonsense knowledge databases such as ConceptNet (Liu and Singh, 2007), word similarity measures using WordNet (Fellbaum, 1999), rules for determining text polarity using word and part-of-speech composition rules (Al Masum et al, 2007), statistical and machine learning methods (Wiebe et al., 2005). To our knowledge, there has been little work done towards obtaining lexical databases of affective terms on other languages than English (Mihalcea et al., 2007) and no work that included motivational theories to fundament the emotional effect of text.

The method presented herein was developed in view of a novel perspective of emotion detection and interpretation, based on the defined notions of ¨emotion triggers.

An ¨emotion trigger¨ is a word or concept expressing an idea, that depending on the reader´s world of interest, cultural, educational and social factors, leads to an emotional interpretation of the text content or not. Examples of emotion triggers are ¨freedom¨, ¨salary¨, ¨employment¨, ¨sale¨, ¨pride¨, ¨esteem¨, ¨family¨ and so on. We will use this defined notion to build a database of such emotion triggers, classify them and integrate them in a system which spots and classifies text valence and emotion.

2 Theories and Resources

The motivation for introducing the concept of ¨emotion triggers¨ is found in the assumptions and principles of the relevance theory from pragmatics. Abraham Maslow´s theory of human motivation and its corresponding pyramid offer the method to classify the emotion triggers and create rules of emotion trigger interaction. In parallel, we apply Neef´s matrix of fundamental human needs to create a need-satisfier system of emotion triggers.

2.1 Theory of Relevance

¨The Theory of Relevance¨ (Sperber and Wilson, 2004), from pragmatics, states in the cognitive principle that ¨human cognition tends to be geared toward the maximization of relevance¨, that is, from the multiple stimuli present in a communication, be it written or spoken, a person will choose the one with highest significance to its world of interest, activating the stimuli whose interpretation could bring it important information and inhibiting those it holds as unimportant. These statements, together with the principles of the relevance theory, can be seen to explain also the process of emotionally interpreting a text.

The theory of relevance contains no explicit mentioning or classification of what could constitute stimuli to a person. To that respect, we considered a good classification the one made by Abraham Maslow, under the form of a 5-level pyramid of human motivations.

2.2 Maslow´s Pyramid of Motivations

Abraham Maslow (Maslow, 1943), classified the human needs and motivational factors into a 5-level pyramid, from the basic, physiological ones, to the more education and personal level of development dependent ones. Needs as food, shelter, peace are at the bottom of the pyramid, whereas needs for self achievement, fame, glory are at the top. The basic needs are the general human ones; as we move towards the top, we find the more individual dependent ones.

2.3 Neef´s Matrix of Fundamental Human Needs

Among the critics of the Maslow theory of human needs is Manfred Max Neef, whose theory (Max-Neef, 1991) describes the economical perspective of fundamental human needs. According to Max-Neef, human needs are equally important, few, finite and classifiable. Max-Neef classifies the fundamental human needs as: subsistence, protection, affection, understanding, participation, recreation, creation, identity and freedom. Needs are also defined according to the existential categories of being, having, doing and interacting, and from these dimensions, a 36 cell matrix is developed.

3 Emotion Trigger Method

Our emotion trigger method starts from the idea that words in text carry no affectivity, but become emotionally charged depending on the interpretation they are given by each reader´s world of interest and the intention and world of interest of the author. This world of interest is made up of general, personal needs and motivation factors, notions satisfying these needs, knowledge on the historical and social facts, information vehiculated in the media (media news) and so on. We call this collection of factors "bag of knowledge" (figure 1).

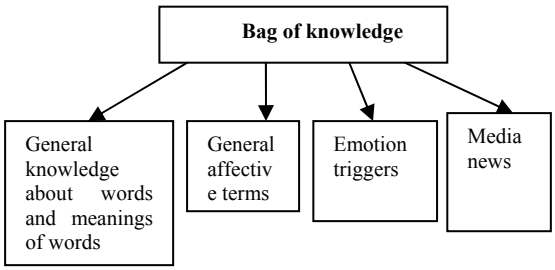

Figure 1. Model for the reader analysis of text

The first component of the bag of knowledge is made up of general knowledge about words and meanings of words. It contains what words can mean, the manner in which they are linked, how they change their meaning. The second component is formed of general affective terms, as ¨kind-hearted¨, ¨furious¨, ¨anxious¨, ¨fear¨ and so on. They express emotion, but do not necessarily induce emotion. For example, a title such as ¨Feared opponents, defeated without problems¨ has no connection to the idea of fear. Such classification of words can be found in lexical affective resources such as WordNet Affect or SentiWordNet. The third component is made up of emotion triggers. It contains the terms that carry in themselves an emotion or a conjunct of emotions, each in a certain percentage. Such a resource has not been built so far and constructing it is the starting point of our method. The fourth component is period, culture and place dependent. It consists of the concepts that become emotion triggers due to the degree of importance they are given in the media, in conjunct with the emotions they are associated with. Also, important events in the history or recent past of an individual, as well as society are considered as being emotion triggers. Examples of such emotion triggers are ¨9/11¨, ¨Second World War¨ etc. It is important to make the observation that these four components are not disjoint sets, neither are they fixed as components or constant among individuals. On the contrary, each can evolve in time, when ordinary words become emotion triggers and when emotion triggers in the fourth component lose impact and become ordinary words. Furthermore, by using the principles of the theory of relevance, we state that the ¨bag of knowledge¨ (BK) consists of different levels of factors, different as importance and by assigning this importance quotient, a system analyzing text will be able to tell the difference between relevant and irrelevant information. We further consider that the interpretation is also dependent on the source of the text and the relation the reader has with it or the a priori knowledge on the degree of trust, reliability of the text source or the attitude of agreement or disagreement of the reader towards the latter. Figure 2 shows the architecture for the analysis of emotion in text:

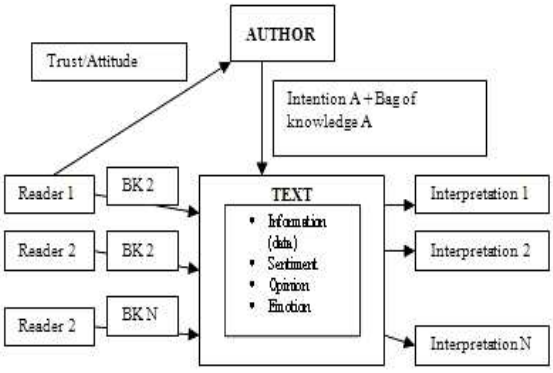

Figure 2. Architecture for the analysis of emotion in text

The system implemented by following the above architecture identifies the corresponding

¨bag of knowledge¨ of a reader and uses it to spot and classify text valence and emotion according to it.

In the following subsections, we start by presenting the steps we performed in order to build the lexical databases of emotion triggers for English and Spanish, the process of mapping the concepts found in English to their correspondents in Spanish and the process of projection to culture dependent knowledge bases for both languages. Further, we explain the method used for assigning valence and classifying emotion induced by emotion triggers. We then present the words and rules that influence the basic valence and emotion in a context and finally the rules of emotional inference derived from the theories underlying this method.

3.1 Constructing and Expanding the Core of Emotion Triggers

The core of English emotion triggers is built, at the first stage, of the approximately 37 terms found in Maslow´s pyramid of human needs, structured on 5 levels starting from the terms corresponding to the deficiency needs, found on the four bottom levels and having on top the growth needs terms, of achieving the personal potential, on level 5.

Since most of the words are general notions and their number is relatively small (37), we disambiguate them with the sense numbers they have in WordNet 2.1, in order to ensure that further on, the added words will remain with the intended meaning. For each term, we add all the senses and all grammatical categories that are valid in the context of Maslow´s pyramid levels. We then add to these words the corresponding synonyms and hyponyms from WordNet. For the verbs considered, we also add the entailed actions. We consider as having a negative value the emotion triggers that are antonyms of the nouns found. For each of the nouns and verbs, we further add the corresponding nouns and verbs, respectively, using NomLex (Macleod et al, 1998). Since NomLex does not assign sense numbers to distinguish between the possible semantics of the nouns and verbs in the collection, we use the Relevant domain concept and corresponding repository (Vázquez et al, 2007) to preserve the intended meaning, by taking the top relevant domain of each word sense and assigning the corresponding verb or noun in NomLex the sense number that has the same top relevant domain. If more such senses exist, they are all added.

On the other hand, the core of English words is completed with the terms found in Max Neef´s matrix of fundamental human needs. This matrix is built according to the four main characteristics of the individual: being, having, doing and interacting, for which terms are assigned in order to nine categories of needs: identity, subsistence, affection, creation, protection, freedom, participation, leisure and understanding.

Building the core of words corresponding to the taxonomy proposed by Neef is done in the same manner as presented above.

3.2 Mapping of Concepts

Using EuroWordNet, we map the words in the English lexical database of emotion triggers to their Spanish correspondents, preserving the meaning through the WordNet sense numbers.

3.3 Adding World Knowledge to the Lexical Databases

The final step in building the lexical databases consists of adding real-world situations, cultural-dependent contexts terms to the two lexical databases. For English, we use the ConceptNet to add culture specific actions and terms related to the considered core of words. For Spanish, we add the cultural context by using the Larousse Ideological Dictionary of the Spanish Language.

3.3.1 ConceptNet

ConceptNet[1] is a freely available commonsense knowledgebase and natural-language-processing toolkit which supports many practical textual-reasoning tasks over real-world documents. Commonsense knowledge in ConceptNet contains relations such as CapableOf, ConceptuallyRelatedTo, IsA, LocationOf etc. For the purpose of maintaining the originally intended meaning of the emotional triggers in the lexical database constructed so far, we chose to project the emotion triggers only based on the relations DefinedAs, LocationOf, CapableOf, PropertyOf and UsedFor.

[1] http://web.media.mit.edu/~hugo/conceptnet/

3.3.2 Larousse Dictionary of the Spanish Language

The Larousse Ideologic Dictionary of the Spanish Language (LIDSL) is made up of four parts: a general classification frame, a synoptic part, an analogic part and an alphabetic index. The Dictionary offers a two-way view on words and ideas they express, thus semantically relating terms pertaining to the same idea and also, given one idea, gathering in frames all concepts related to it. In using this resource, we start from the parallel core of concepts representing the levels of needs and motivations, completed as stated before with the synonyms, hyponyms and antonyms found in WordNet, and add the Spanish culture specific terms related to them. For example, from the general concept of ¨comida¨ (¨food¨), we find as subordinated concepts ¨carne¨ (¨meat¨), ¨fruit¨ (¨fruta¨), ¨verdura¨ (¨vegetables¨) etc. These concepts are further refined to specific notions that are types of meat found in the real world: In the case of ¨carne¨, some examples are ¨vaca¨, ¨ternera¨, ¨carnero¨, ¨cordero¨, ¨matanza¨, ¨chicha¨.

3.4 Adding Valence and Classifying Emotion

Having at hand a lexical database of emotion triggers constitutes the first step towards the building of a system conforming to the architecture described in Figure 3., that spots possible emotional interpretation of texts in a culturally specific way, parting from the general motivational traits applicable to the whole human species.

The next step taken consists in assigning valence and emotion to the terms in the database. This is done with the following rules, both for the terms in Maslow´s pyramid as well as for those in Neef´s matrix:

1. The primary emotion triggers are assigned a positive value.
2. The terms (also emotion triggers in the final lexical database) synonym and hyponym of the primary emotion triggers, as well as the entailed verbs are assigned a positive value
3. The terms opposed and antonym of those from 1. and 2. are assigned a negative valence.
4. Emotion triggers added further on inherit the valence from the emotion trigger they are related to in case of synonyms, hyponyms and entailment and change their valence from positive to negative or negative to positive in the case of antonyms.
5. Value of all emotion triggers is modified according to the valence shifters they are determined by.

Further on, we assign an emotion triggers a value of the 6 categories of emotion proposed for classification in the SemEval Task No. 14 – joy, sadness, anger, fear, disgust and surprise, using the following rules:

1. The emotion triggers found in the levels of Maslow´s pyramid of needs and those found in the components of Neef´s matrix of fundamental human needs are manually annotated with scores for each of the 6 categories
2. The primary emotion triggers are assigned values for each emotion.
3. The terms (also emotion triggers in the final lexical database) synonym and hyponym of the primary emotion triggers, as well as the entailed verbs are assigned inherited values.
4. The terms opposed and antonym of those from 1. and 2. are assigned manually a value for each emotion.
5. Emotion triggers added further on inherit the valence from the emotion trigger they are related to.
6. Value of all emotions of an emotion triggers is modified according to the valence shifters they are determined by.
7. If any of the values calculated in 6 is higher than 100, it is set to 100.

3.5 Valence Shifters

In order to be able to recognize the change in meaning of emotion triggers due to modifiers, we have defined a set of valence shifters – words that negate the emotion triggers, intensify or diminish their sense. The set contains:

Words that introduce negation (no, never, not, doesn´t, don´t and negated modal verbs)

A set of adjectives that intensify the meaning of the nouns they modify – big, more, better etc.

A set of adjectives that diminish the meaning of the nouns they modify – small, less, worse, etc.

The set of modal verbs and conditional of modal verbs that introduce uncertainty to the active verb they determine- can, could, might, should, would.

The set of modal verbs that stress on the meaning of the verb they determine – must etc.

A set of adverbs that stress the overall valence and intensify emotion of the context – surely, definitely, etc.

A set of adverbs that shift the valence and diminish emotion of the context – maybe, possibly, etc.

For each of the valence shifters, we define a weight of 1.5 for the meaning intensifiers and 0.5 for the meaning diminishers. These coefficients will be multiplied with the weight assigned to the emotion trigger level and emotions- level association ratio corresponding to the given emotion trigger in the case of emotion triggers built from Maslow´s pyramid. In the case of emotion triggers stemming from Neef`s matrix of fundamental human needs, the weights of the valence shifters are multiplied with the emotion-category association ratio, computed for each emotion trigger and each of the four existential categories.

3.6 Emotion Trigger Association Ratio

The association ration score provides a significance score information of the most relevant and common domain of a word.

In our approach, besides quantifying the importance of each emotion trigger in a manner appropriate to the level and emotion it conveys, we propose to use a variant of the association ratio that we call emotional association ratio per level or category. This score will provide the significance information of the most relevant emotion to each level and category. The corresponding formula is therefore:

$$AR(e;L) = \Pr(e,L)\log_2 \frac{\Pr(e,L)}{\Pr(e)\Pr(L)}$$, where

- Pr(e,L) is the probability of the emotion in the given level
- Pr(e) is the probability of the emotion
- Pr(L) is the probability of the level or category

3.7 Construction-Integration Model

The Construction-Integration Model is a psychological model of text comprehension (Kintsch, 1999), based on the idea that while reading a text, a person will activate the features of words that are appropriate to the context and inhibit those that are not.

The construction-integration model has been so far successfully used in the field of Natural Language Processing for anaphora resolution, generation of representations of word meanings from dictionaries (Powell et al, 2000) and automatic assessment of summarizations (Lemaire et al., 2005). Also, its author also proposed a computational method for metaphor comprehension (Kintsch, 2000) based on this cognitive model.

4 System for valence and emotion

The final system built to classify text at valence and emotion level follows a series of steps. First, the input text is parsed with Minipar (Lin, 1998) and Freeling[2] for Spanish to obtain for each word the grammatical category, the lemma and its modifiers. Further on, the emotion triggers in the text are identified, together with their corresponding modifiers.

We calculate the valence of the text on the basis of the identified emotion triggers and their modifiers, using the formulas described in what follows.

In the case of emotion triggers obtained from Maslow´s pyramid, we calculate a score called weighted valence of emotion trigger(wv) using the following formula:

$$wv(et_{ij}) = w(m) * w(l_j) * v(et_i)$$, where

- w(m) is the weight of modifier
- w(lj)is the weight of level
- v(eti)is the emotion trigger valence
- i is the index of the emotion trigger
- j is the number of the level

In the case of emotion triggers obtained from Neef´s matrix, we calculate a score called weighted valence of emotion trigger(wv) using the following formula:

$$wv(et_i) = w(m) * v(et_i)$$, where

- w(m) is the weight of modifier
- v(eti)is the emotion trigger valence
- i is the index of the level

The total valence of text is equal to the sum of all weighted valences of all emotion triggers in the text. For values lower than -50, the final value assigned is -1, for values between -50 and 50 the final value is set to 0 and for values higher than 50, the final value will be 1.

[2] http://garraf.epsevg.upc.es/freeling/

Further, we calculate the emotions present in the text, by computing the emotion to level association ratio for each emotion trigger stemming from Maslow´s pyramid and the emotion to category association ratio for each emotion trigger from Max-Neef´s matrix.

We then apply the Contruction Integration Model and construct a spreading activation network. We consider the working memory as being composed of the set of emotion triggers and their association ratio value which is considered as activation value. The semantic memory is set up of the modifiers and the top 5 synonyms and antonyms of emotion triggers with their AR value. We set the value of each emotion trigger to 1. We create a link between all concepts in the semantic memory with all the emotion triggers. We consider the strength of link the higher of the two emotional AR scores. The text is processed in the order in which emotion triggers appear and finally we obtain the activation value for each emotion trigger. The output values of the emotions in text is obtained by multiplying the activation values with 100 and adding the scores obtained for the same emotion from different emotion triggers when it is the case. The values of emotions higher than 50 are mapped to 1 and the values lower than 50 are mapped to a final value of 0 for the emotion.

5 Experiments and evaluation

The evaluation of the system presented was done using the test data provided within the SemEval Task No. 14: Affective Text test set (Strapparava and Mihalcea, 2007) and its Spanish translation. In the task proposed in SemEval, the objective was to assign valence – positive or negative - and classify emotion of 1000 news headlines provided as test set according to 6 given emotions: joy, fear, sadness, anger, surprise and disgust and their translation to Spanish. The results we obtained are presented in Table 1 for valence classification and in Table 2 for one of the 6 emotions- fear:

	Acc	Prec	Rec	F
Eng	70.1	75.2	65.0	69.7
Sp	65.0	71.1	66.1	68.5

Table 1. System results for valence annotation

	Acc	Prec	Rec	F
Eng	95.1	47.2	45.3	46.2
Sp	95.2	46.0	43.8	44.8

Table 2. System results for annotation of ¨fear¨

Although the results show relevant improvements over the ones obtained by previously built systems, in using such a complex system, one could and should use a more complex set of emotions. The set of emotions is rather limited and sometimes does not allow for an accurate assignment of the appropriate emotion for the emotion triggers, but a conventional classification.

6 Conclusions and future work

In this paper we presented a method to assign valence and classify emotion in text starting with a database of cultural dependent emotion triggers derived from a theory in pragmatics and 2 motivational and need-based theories. The final classification of texts was done using the cognitive model of construction and integration, the emotion to level and emotion to category association ratio and taking into account valence shifters, outperforming previously obtained results. In order for the system to be complete, we should also build the fourth component of the system, by applying the system on large corpora of news and of world and culture specific data. Part of the future work is also applying a larger set of emotions for classification.

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