Linguistic Rules for Fine-Grained Opinion Extraction

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Abstract

Opinion mining applications are usually classified according to the granularity level they tackle: the document, sentence and aspect levels. In our work, we focus on aspect-based opinion mining, more specifically, on the aspect extraction task, which is essential to perform richer text analyses and produce better results in the area. To the best of our knowledge, no previous systematic effort exists on extraction explicit and implicit aspects for Portuguese. To fill this important gap, in this paper we explore the opinion mining aspect extraction task for Brazilian Portuguese. We performed a linguistic empirical study on relevant proprieties in narratives of product reviews and annotated a corpus manually that we test on three different domains (smartphones, digital cameras and books). Based on this data, we propose linguistic rules for extracting explicit and implicit aspects, which we categorize as psychological verb-based and semantic relation-based rules.

Introduction

According to (Zhao and Li 2009), opinion mining (also known as sentiment analysis) aims at automatically extracting and processing relevant opinions, providing useful information for the interested reader. Differently from traditional text mining, it is predominantly based on subjective text, focusing on specific topics. Moreover, opinions are often subtly and implicitly expressed, showing expressive marks of subjectivity and informality.

There are three usual granularity levels for opinion mining (Liu 2012): the (i) document, (ii) sentence and (iii) aspect levels. At the document level, the sum of the opinions expressed in the document is considered. In this level, a full document is rated as positive, negative, or neutral. At the sentence level, the purpose is to determine the opinion expressed in each sentence of the document. In the most refined level, in order to figure out exactly the object properties that the user liked/disliked, an aspect-based analysis is carried out. For example, in the sentence "It is cheap but the screen resolution is not good, the "price" aspect is well evaluated, while the "screen resolution" is not.

As claimed by (Wu and Liu 2003), aspect-based sentiment analysis consists of 4 main tasks: (i) explicit and implicit aspect extraction; (ii) aspect clustering; (iii) polarity extraction; and (iv) opinion summarization. The aspects of the evaluated object may be explicitly or implicitly expressed. Explicit aspects are those that are cited in the text, e.g., "screen resolution" in the previous example. Implicit aspects, on the opposite, must be inferred and are usually signaled by clue terms. It is the case for the "price" aspect in the example, that was signaled by the word "cheap". In the aspect clustering task, groups of similar aspects must be found, as the user may employ different words to refer to the same aspect, such as "value", "cost" and "investment" to refer to the "price" aspect. For polarity extraction, the expressed sentiments in relation to the cited aspects must be identified and extracted. In our example, one must identify that the "price" shows a positive polarity, while the "screen resolution" shows a negative one. Lastly, in the opinion summarization step, a general overview of the opinions of an object of interest must be produced.

For Portuguese, which is the language of interest here, some previous work on the above steps exist. For instance, (Balage Filho and Pardo 2014) proposed a machine learning-based approach for explicit aspect extraction. (Vargas and Pardo 2018) studied methods for aspect clustering using varied knowledge sources. (Avanço and Nunes 2014) explored a lexicon-based method for polarity classification. (Condori 2014) built extractive and abstractive opinion summaries. To the best of our knowledge, no previous systematic effort exists for describing and extracting explicit and implicit aspects using linguistic patterns for Portuguese. Explicit and implicit aspects are still a challenge in the area because natural languages allow expressing subjectivity in varied ways. For instance, the aspects may be signaled by single words or expressions (sometimes accounting for the whole sentence) and use different part-of-speech tags.

In this paper, we present a set of linguistic rules for aspect extraction in Brazilian Portuguese language. Firstly, we study the main linguistic events in subjective narratives, which may be seen at (Vargas and Pardo 2017a) and (Vargas and Pardo 2017b). Additionally, we propose an annotation methodology for aspect identification and clustering

that we test on three different domains (smartphones, digital cameras and books) and produce a reliable annotated corpus. The annotation methodology and the annotated corpus may be accessed at (Vargas and Pardo 2017a). Based on this data, we propose linguistic rules for extracting aspects, which we categorize as psychological verb-based and semantic relation-based rules.

The remainder of this paper is organized as follows. In Section 2, we present the related work. In Section 3, we describe the corpus and in the Section 4, we detail the linguistic-based rules. Finally, in Section 5, we make some final remarks.

Related Work

Aspect extraction is an aspect-based sentiment analysis task, which consists of the automatic information extraction on subjective text. The first one study related to aspect extraction has been proposed by (Hu and Liu 2004) and (Liu 2012), who also introduced the distinction between explicit and implicit aspects. In this paper, we focus on aspect extraction task, more specifically, the rule-based approaches.

On linguistic rules approaches, in (Liu 2012), was proposed a word-based translation model (WTM) method in order to find the main associations between aspects and polarity. In this proposal, it has been considered noun/noun phrases as potential aspects and adjectives as their polarity. In other work proposed by (Poria et al. 2014), the authors developed a parser for explicit and implicit aspect extraction from product reviews. They employed a set of syntactic rules focused, mainly on sentences which obtained subject noun and sentences which do not obtained subject noun. Additionally, has been considered rules using the position relations among modifier of noun. The authors related good results that overcame the others implemented methods. In (Wu et al. 2009), the authors present a new tree nucleus function to model the phrase dependency trees. First one, they constructed phrase dependency tree from the results of chunking and dependency parsing. The second step consist in the extracting candidate product features and candidate opinion expressions. In the last step, it is performed the extracting relations between product features and opinion expressions. The experimental results showed that this approach improved the performances of the aspect extraction task. For Brazilian Portuguese, to the best of our knowledge, no previous effort exists on linguistic rules-based approach for aspect extraction task in fine-grained opinion mining applications.

The Corpus

An overview of the dataset that we use in this paper is shown in Table 1. According to (Zhao and Li 2009), most of the existing opinion mining initiatives are based on product reviews because reviews usually focus on specific products and contain little irrelevant information. Therefore, we randomly selected 60 smartphone and 60 digital camera reviews from the Buscapé corpus (Hartmann et al. 2014) and 60 book reviews from the ReLi corpus (Freitas et al. 2012).

Table 1: Dataset Overview

Domain	Reviews	Tokens	Types
Book	60	35,771	1,577
Smartphone	60	6,077	1,496
Camera	60	3,887	1,060

The Buscapé corpus is composed of product reviews for cameras, notebooks, telephones, TVs, etc. In this corpus, the reviews are partially structured, with sections for "overall impression", "what I liked" and "what I did not like". For example, see the following camera review: *Excelente, ate hoje todo mundo se impressiona com o tamanho e a beleza dela, alem de fotos perfeitas que podem ser tiradas até 6.3 megapixels! o que gostei: Fina, pratica e leve. o que não gostei: Nenhum!*[1]. One may notice that several aspects were evaluated in this review, but some are not explicit. For example, the terms *beleza*, *fina*, *pratica* and *leve* are clues that indicate the implicit aspects "design", "size", "usability" and "weight", respectively.

ReLi corpus consists of narratives on book reviews extracted from Skoob social media (skoob.com.br). The ReLi is composed by 1600 reviews of 14 different books, accumulating 12.470 sentences and 259.978 words. As an example, one may find the following review: *Ótimo livro, bem diferente do que eu imaginava. Apesar de antigão, é uma leitura gostosa, com a linguagem bem moderna. Um livro adolescentes, de aqueles momento foda-se*[2]. In general, it is possible to notice the challenges in dealing with such texts. They are usually marked by orality and informality, orthographic and grammar errors, and bad language occurrences.

Linguistic Rules for Aspect Extraction

In (Vargas and Pardo 2017a) and (Vargas and Pardo 2017b), we performed a linguistic empirical study on relevant proprieties in narratives of subjective text for Portuguese. We also annotated explicit and implicit aspect and their respective groups that we test on three different domains (smartphones, digital cameras and books). Based on this data, we propose linguistic rules for extracting explicit and implicit aspects, which we categorize as psychological verb-based and semantic relation-based rules. which are described below.

Psychological verb-based rules

Psychological verbs denote a particular state related to the psychological state. The literature of the last three decades (a.o. (Perlmutter and Postal 1984), (Rosen 1984), (Grimshaw 1990), (Pustejovsky 1991) (Pesetsky 1995), (White 2003), (Levin and Rappaport Hovav 2005), (Ramchand 2008)) has aimed to capture specific pattern of behav-

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[1]In English: "Excellent, to this day everyone is impressed by her size and beauty, plus perfect photos that can be taken up to 6.3 megapixels! What I liked: Thin, practical and light. what I didn't like: None!"

[2]In English: "Great book, quite different from what I imagined. Although ancient, it is a delicious read, with very modern language. A teens book, of those moments you want everything to go to hell"

ior on semantic and syntactic structure of psych verbs. For Portuguese, in (Belletti and Rizzi 1988), (Oliveira 1979) and (Cancado 1995) was proposed the classification of syntactic-semantic proprieties for psychological verbs from empirical study.

In this paper, we propose two set of rules for aspect extraction using psychological verbs-based rules and also semantic relation-based rules. For psychological verbs-based rules, we analyzed the occurrence of Brazilian Portuguese psych verbs [3] in narratives of product reviews. The results is shown in the Table 2.

Table 2: Psychological verbs occurrence in product reviews.

Domain	Reviews	Psych Verbs	%
Smartphone	60	60	100
Camera	60	60	100
Book	60	52	86.66
Total	180	172	95.55

The psychological verbs occurred at least one time in 86.66% of book reviews and 100% of smartphone and camera reviews. Considering this relevant occurrence in the corpus, we model linguistic proprieties of psych verbs and proposed a set of rules for aspect extraction in opinion mining. We classify four main rules according to the Table 3. The four rules will be described in detail to follow.

Table 3: Psychological verb-based rules for aspect extraction.

Rules	Linguistic Properties
Rule 1	It admits ergativity
Rule 2	It admits syntactic and adjective passivization
Rule 3	It admits *pro* arbitrary as subject
Rule 4	It admits headed causative sentence

Rule 1: It admits ergativity. The first rule consists in the ability of the verb to accept ergative constructions. According to (Belletti and Rizzi 1988), the ergativity is a syntactic proprieties that occurs with some direct transitive verbs such as occurs in a passive, whereby the sentence subject is omitted. Thereby, it occurs the stand taken of subject by first argument position (intern argument of the argument structure). Moreover, the ergativity only occur when the intern argument have as property to be affected by process. An example of ergative construction in review on book is showed in the Figure 1. [4].

In the Figure 1, we observed that the aspects position ("bateria", "price" and "smartphone") occurs always before psych verb and inside a NP. Moreover, the aspects appears in two main structures: the first structure is composed by a NP whose the nucleus is a noun accompanied by a psych verb. The second structure is composed by a NP followed by VP,
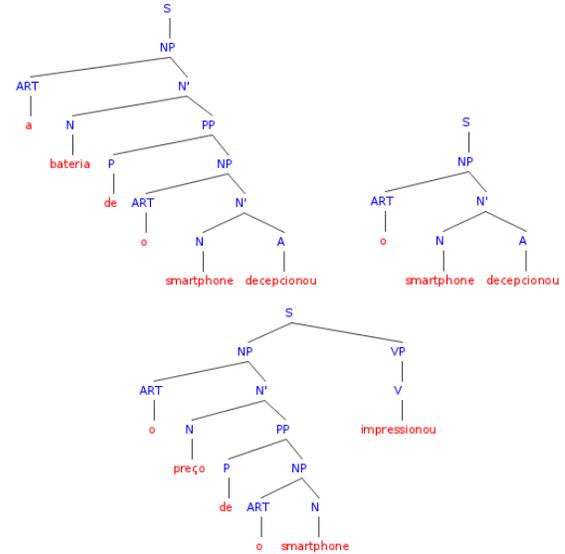
Figure 1: Example of ergative constructions in smartphone reviews.

where the nucleus of VP is a psych verb. In the Algorithm 1 below, we described the entire rule.

Algorithm 1 Aspect extraction using ergativity

1: A = aspect
2: P = psych verbs
3: S = sentence
3: **if** VP occurs in S and the nucleus of this VP is a P **then**
3:     $A \Leftarrow$ the nucleus of NP in the left position of VP
3: **else if** NP occurs in S and the nucleus this NP is followed by P **then**
3:     $A \Leftarrow$ the nucleus of NP

Rule 2: It admits syntactic and adjective passivization. The second rule consists in constructions that admits syntactic and adjective passivization as shown in Figure 2 [5]. In (Cançado 2002), you may obtain a whole description on syntactic and adjective passivization on Brazilian Portuguese psych verbs.

See that the two reviews is represented over the same structure: a NP followed by VP, where the VP is composed by [verb to be] + [past participle of the psych verb]. The aspects ("smartphone", "zoom" and "câmera") appears as nucleus of NP. In this settings, we describe this entire rule in the Algorithm 2 bellow.

Rule 3: It admits *pro* arbitrary as subject. The third rule covers sentences whose *pro* arbitrary performs the function of subject. An example is displayed by Figure 3 [6]. Accord-

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[3] https://github.com/francielleavargas/psycverbs.br

[4] Sentence adaptation for English: (i) the first one syntactic tree: "the smartphone's battery disappointed"; (ii) the second syntactic tree: "the smartphone disappointed"; (iii) the third syntactic tree: "the smartphone's price disappointed".

[5] Sentence adaptation for English: (i) the first one syntactic tree: "this smartphone is wished by all the people"; (ii) the second syntactic tree: "I was fascinated with the camera's zoom ".

[6] Sentence adaptation for English: (i) the first one syntactic tree: "(they) hated the smartphone's design"; (ii) the second syntactic
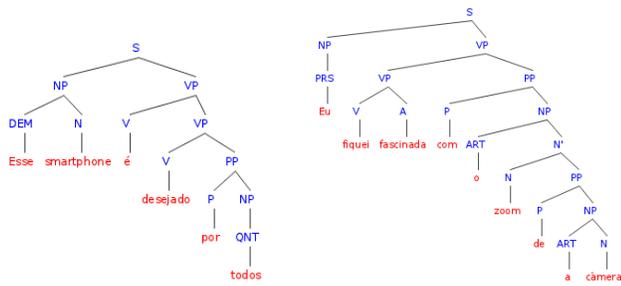
Figure 2: Example of syntactic and adjective passivization in smartphone and camera reviews.

Algorithm 2 Aspect extraction using syntactic and adjective passivisation

1: A = aspect
2: B = auxiliary verb (to be)
3: P = psych verbs
4: S = sentence
4: **if** VP occurs in S and the nucleus of VP is a B followed by P in the past participle (verbal temp) **then**
4:    $A \Leftarrow$ the nucleus of NP in the right position of the VP
4: **else if** NP occurs in S followed by a VP where the nucleus this VP is a P **then**
4:    $A \Leftarrow$ the nucleus of NP in the left position of VP

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ing to (Cançado 2002), the *pro* arbitrary is an indeterminate subject marked by verbal flexion of the 3rd person plural.

Note that the aspects("design", "preço", "smartphone", "câmera", "personagens", "história" and "livro") occurs in the right position of the VP where the psych verb appear. Therefore, we describe the Algorithm 3 as shown below.

Algorithm 3 Aspect extraction using *pro* arbitrary as subject

1: A = aspect
2: B = auxiliary verb (to be)
3: M = psych verbs
4: S = sentence
4: **if** VP occurs in S and the nucleus of the VP is a B followed by M in the past participle (verbal temp) **then**
4:    $A \Leftarrow$ the nucleus of NP in the right position of the VP
4: **else if** NP in S where occur M **then**
4:    $A \Leftarrow$ the nucleus of NP that being a NOUN in the left position of the VP

Rule 4: It admits headed causative sentence. Characterized in (Cançado 2002), the group of psych verbs allows headed causative clauses (using the "do" verb). In order to exemplify it, the Figure 4 [7] show the occurrence of headed causative sentence in smartphone and book reviews.

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tree: "(they) hated the camera's camera"; (iii) the third syntactic tree: "(they) hated the history's character from book".

[7]Sentence adaptation for English: (i) the first one syntactic tree: "the design and size of the smartphone did my boyfriend to love the smartphone"; (ii) the second syntactic tree: "the history and
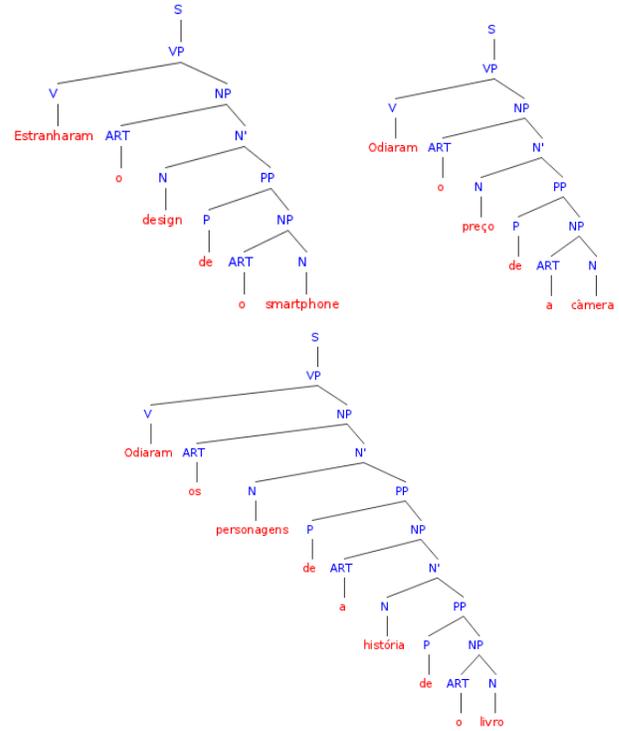
Figure 3: Example of constructions *Pro* arbitrary as subject.
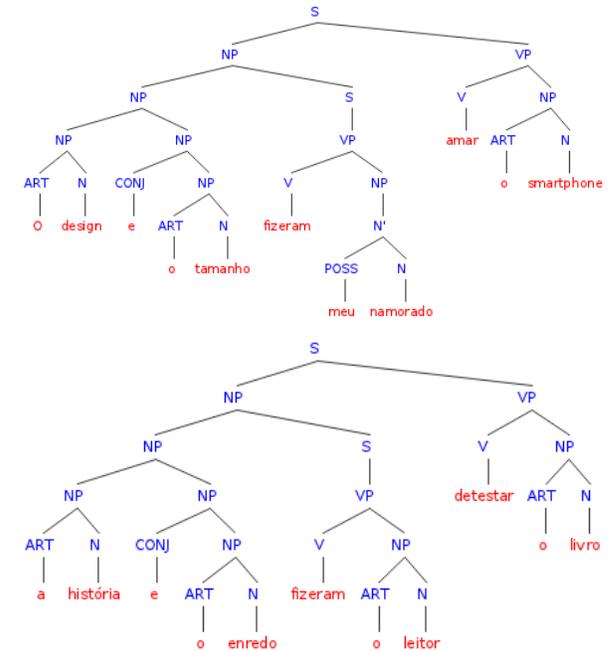
Figure 4: Example of headed causative sentence in smartphone and book reviews.

In constructions that admits headed causative, the aspect may occurs in the right position of the VP whose the nucleus is a auxiliary verb and occurs as nucleus of the NP leftmost (see Figure 4:"design", "tamanho", "história", "enredo" and "leitor"). Furthermore, we identified aspects inside the VP rightmost where the psych verb occurred. (see Figure 4: "smartphone" and "book"). Hence, it became possible to obtain aspect using Algorithm 4 described below.

Algorithm 4 Aspect extraction using headed causative sentence

1: A = aspect
2: D = auxiliary verb (to do)
3: P = psych verbs
4: S = sentence
4: **if** [ŃP VP VP] occurs in S and the nucleus of the first VP is a D and the nucleus of the second VP is a P **then**
4:     $A \Leftarrow$ the nucleus of NP in the right position of the first VP
4: **else if** [VP VP] occurs in S and the nucleus of the first VP is a D and the nucleus of the second VP is a P **then**
4:     $A \Leftarrow$ the nucleus of NP in the right position of the both VP's

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Semantic relation-based rules

During the annotation process, we observed various interesting linguistic events in subjective text. We identified the relevant presence of psychological verbs and also a set of semantic relations that are more frequent than others. This last, the set of rules – the semantic relation-based rules – looks for relevant semantic relations between aspects that may indicate their occurrence. The identification of these semantic relations has been based on an empirical linguistic study (Vargas and Pardo 2018) . Table 4 indicates the semantic relations used in each domain.

Table 4: Semantic relations among aspects (%).

Relation	Smartphone	Camera	Book	Avg
Is-a / hypernym	45.00	37.12	46.60	42.90
Synonym / identity	23.88	18.93	26.21	23.00
Part-of / metonym	8.88	15.90	7.76	10.84
Deverbal construction	5.55	6.81	9.70	7.35
Coreference	6.66	8.33	0.00	4.99
No-relation	10.00	13.63	9.70	11.11

The relations among aspects named *i-sa* or hiperonym/hiperonymy occurred in 45% in smartphone domain, 37,15% in digital camera and 46,60% in the book domain. Furthermore, synonym and *part-of* or metonymy/meronymy relations presented also a relevant number as shown by Table 4. Based on this data, we identified that the aspects in narratives of product reviews are related mainly by *i-sa*, *part-of* and *synonym* relations. In other words, for aspect extraction task, the identification, particularly this set of semantic relations, may indicate the aspect presence. In order to exemplify this phenomenon, In Figure 5 it is shown some examples of related aspect in each semantic relation.

As showed in the Figure 5, the aspects is may be found from semantic-relations among them. For example, the aspects "preço", "custo" and "valor" (*price, cost, value*) is

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plot did the reader hated the book".
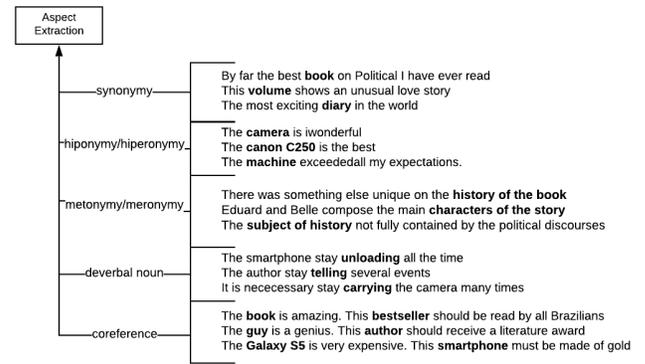
Figure 5: Example of semantic-relation among aspects in narrative of product reviews.

related by synonymy relation. For *i-sa* relation, the aspect "câmera" *i-sa* "maquina" (*camera, machine*). The *part-of* relation may be found from "resolução da câmera" and ""foco da câmera" (*camera resolution, camera focus*) aspects. In other words, we may say that the "foco" is *part-of* "câmera" (*camera, focus*). In the conference, which according to (Mitkov 2002), consists of a phenomenon that occurs when two or more elements in text or sentence refers to the same entity in the real world, the pairs of aspects "livro" and "bestseller" (*book, bestseller*), as well "cara" and "autor" *guy, author* are examples this kind of semantic relation. The deverbal nouns is nouns derived from verbs. For implicit aspect extraction, we realized that deverbal constructions occurred in our corpus in 100% of the time as a clue term. For example, the deverbal nouns "descarregando" and "durando" (*unloading, lasting*) is a clue term that indicate a implicit aspects respectively "bateria" and "durabilidade" (*battery and durability*). Beyond the relations displayed in the Figure 6, there has been two interested linguistic phenomena among aspects inserted in the no-relation category (see Table 4). The fist one is the foreignness, and the second is diminutive and augmentative. For example, the aspects "memória" (*memory*) and "memory stick" is related by foreignness phenomena; and the aspects "livro" and "livrinho" (*book and booklet*) is related by diminutive phenomena.

Final Remarks

In this paper, we produced 180 labeled reviews for Portuguese. We labeled each explicit and implicit aspect and identified groups of similar aspects. Furthermore as a result of corpus study, we reported two set of rules for explicit and implicit aspect identification: (i) psychological-verb based and (ii) semantic-relation based rules. In the first set of rules, we model semantic-syntactic proprieties from psychological verbs and create rules for explicit and implicit aspect extraction. In the second set of rules, from empirical study, we identified a set of semantic relations that are more frequent than other among aspects in narratives of subjective texts. For future works, we intend to provide more annotated narratives of subjective text, specially on social media.

Furthermore, we also intend to implement and evaluate a fine-grained opinion mining parser, based on this work, that allows the automatic identification of explicit and implicit aspect for Portuguese language. The resources developed in this work may be found at OPINANDO project [8].

Acknowledgments

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[8]https://sites.google.com/icmc.usp.br/opinando/