Morphological Relations for the Automatic Expansion of Italian Sentiment Lexicons

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Abstract. This paper introduces a morphological method for the expansion of Italian Sentiment Lexicons. The purpose of the work is to exploit the existing resources of Nooj in order to make unknown words automatically inherit the semantic information associated to the known items, tanks to derivation phenomena. The research did not focused only on the propagation of the semantic tags, but explored also the reversion, the intensification and the weakening of the words by the effect of special kinds of morphemes.

1 Introduction

The present research proposes a morphological strategy for the enlargement of electronic dictionaries of sentiment in the Italian language. The paper will show the possibility to double the dimension of existing sentiment dictionaries, thanks to derivational phenomena. The inputs are SentIta, a manually built Nooj lexicon of Italian words that, among other part of speech, includes more than 5,000 adjectives of sentiment (Maisto 2014); a list of prefixes and suffixes and a set of Nooj morphological grammars, able to put in relation sentiment words and affixes and to modify, in many different ways, the grammatical category, the semantic orientation (positive/negative), or the intensity (strong/weak) of the starting lemmas.

In detail, our work takes advantage of derivation linguistic clues that put in relation semantically oriented adjectives with quality nouns (e.g. *bello* "beautiful", *bellezza* "beauty") and with adverbs in *-mente* (e.g. *dolce* "sweet", *dolcemente* "sweetly"). The purpose is making new words automatically derive the semantic information associated to the adjectives which they are morpho-phonologically related with.

Furthermore, we use as morphological Contextual Valence Shifters (mCVS) a list of prefixes able to negate (e.g. *anti-*, *non-*, ect…) or to intensify/downtone (e.g. *arci-*, *semi-*, ect…) the orientation of the words with which they occur. Thus, if the just mentioned suffixes can interact with pre-existing dictionaries of the Italian module of Nooj, in order to automatically tag them with new semantic descriptions; the cited prefixes can directly work on opinionated documents, so Nooj can "understand" the actual orientation of the words occurring in real texts.

The evaluation of the precision reached by the automatically built dictionaries and the error analysis will be discussed in detail in the next paragraphs.

We clarify in advance that the morphological method could have been applied also to Italian verbs, but we chose to avoid this solution because of the complexity of their argument structures. We decided, instead, to manually evaluate all the verbs described in the Italian Lexicon-grammar binary tables, so we could preserve the different lexical, syntactic and transformational rules connected to each one of them (Pelosi 2015, Pelosi et al. 2015).

The paper is structured as follows: Section 2 introduces Sentiment Analysis, focusing on the state of the art sentiment lexical databases for the Italian language; Sect. 3 rapidly explores the literature on sentiment lexicon propagation; Sect. 4 describes the rules on which the derivation of adverbs has been performed in this research; Sect. 5 goes in depth in the derivation of quality nouns from qualifiers adjectives; Sect. 6 clarifies the ways in which mCVS can be used in real text occurrences and, in the end, Sect. 7 concludes the work and introduces the improvements that the research still needs.

2 Sentiment Analysis Grounded on Lexicons

Among the most used approaches in the Sentiment Analysis field the lexicon-based methods emerge for popularity. The basic assumption on which they are grounded consists in the idea that the text orientation comes from the semantic orientations of words and phrases occurring in it.

Although hand-built lexicons are more precise than the automatically built ones; to manually draw up a dictionary is a strongly time consuming activity (Taboada et al. 2011; Bloom 2011). That is why the presence of a large number of studies on automatic polarity lexicons creation and propagation can be noticed in literature. Among the most popular lexicons for the sentiment analysis, at least *WordNet-Affect* (Strapparava et al. 2004), *SentiWordNet* (Esuli and Sebastiani 2006) and *SentiFul* (Neviarouskaya et al. 2011) deserve to be cited.

Because the largest part of the state of the art lexicons focuses on the English language, Italian lexical databases are mostly created by translating and adapting the English ones. Steinberger et al. (2012), for example, verified a triangulation hypothesis for the creation of sentiment dictionaries in many languages (namely English, Spanish, Arabic, Czech, French, German, Russian and also Italian).

Baldoni et al. (2012) proposed an ontology-driven approach to Sentiment Analysis, by selecting representative Italian emotional words and using them to query *Multi-WordNet*. The synsets connected to these lemmas were then processed with *WordNet-Affect*, in order to populate the emotion ontology only with the words belonging to synsets that represented affective information. Furthermore, thanks to the *SentiWordNet* database every synset has been associated to the neutral, positive or negative scores.

Basile and Nissim (2013) merged the semantic information belonging to existing lexical resources in order to obtain an Italian annotated lexicon of senses, *Sentix*. They used *MultiWordNet* (Pianta et al. 2002) to transfer polarity information associated to English synsets in *SentiWordNet* to Italian synsets, thanks to the multilingual ontology *BabelNet* (Navigli and Ponzetto 2012).

In the end, Hernandez-Farias et al. (2014) achieved good results in the *SentiPolC 2014* task by semi-automatically translating in Italian different sentiment lexicons; namely, *SentiWordNet*, *AFINN Lexicon* (Hansen et al. 2011), *Whissel Dictionary* (Whissel 1989), etc…

2.1 The SentIta Database

SentIta, is an Italian sentiment lexicon that has been semi-automatically generated at the Department of Political, Social and Communication Science, on the base of the richness of the Italian module of Nooj (Silberztein 2003; Vietri 2014) and the Italian Lexicon-grammar (LG) resources (Elia et al. 1981; Elia 1984). The tagset used for the Prior Polarity annotation (Osgood 1952) of the lexical resources is composed of four tags (POS "positive"; NEG "negative"; FORTE "intense" and DEB "weak"), that combined together generate an evaluation scale that goes from -3 (+NEG+FORTE) to +3 (+POS+FORTE) and a strength scale that ranges from -1 (+DEB) to +1 (+FORTE). Neutral words have been excluded from the lexicon. In detail, the *SentIta* adjectives and bad words have been manually extracted and evaluated starting from the Nooj databases, preserving their inflectional (FLX) and derivational (DRV) properties. Compound adverbs (Elia 1990), idioms (Vietri 1990; Vietri 2011), psych verbs and other LG verbs (Elia et al. 1981; Elia 1984), instead, have been weighted starting from the Italian LG tables, in order to maintain the syntactic, semantic and transformational properties connected to each one of them.

In this paper we just used a fraction of *SentIta*, that in whole contains more than 15,000 sentiment items. In the next paragraphs we will explain the details concerning the rules used to automatically enlarge this lexical database.

3 State of the Art on Sentiment Lexicon Propagation

The literature on lexicon propagation can be easily grouped into three main research lines. The first one is grounded on the richness of the already existent thesauri, *WordNet*, among others. Although *WordNet* does not include semantic orientation information for its lemmas; semantic relations, such as synonymy or antonymy, are commonly used in order to automatically propagate the polarity, starting from a manually annotated set of seed words (Hu and Liu 2004; Kim and Hovy 2004; Esuli and Sebastiani 2006; Maks and Vossen 2011).

The second line of research is based on the hypothesis that the words that convey the same polarity should appear close in the same corpus, so the propagation can be performed on the base of co-occurrence algorithms (Turney 2002; Baroni and Vegnaduzzo 2004; Kanayama and Nasukawa 2006; Qiu et al. 2009; Wawer 2012).

In the end, the morphological approach is the one that employs morphological structures and relations for the assignment of the prior sentiment polarities to unknown words, on the base of the manipulation of the morphological structures of known lemmas (Ku et al. 2009; Moilanen and Pulman 2008; Wang et al. 2011, Neviarouskaya 2010).

4   Deadjectival Adverbs in *-Mente*

As anticipated, this research aims to enlarge the size of *SentIta* on the base of the morphological relations that connect the words and their meanings. In a first stage of the work, more than 5,000 labeled adjectives have been used to predict the orientation of the adverbs which were morphologically related with them. This paragraph will go through the rules exploited to perform the task.

Adverbs are morphologically invariable and, consequently, they do not present any infection. As exemplified below, the great part of them is characterized by a complex structure that includes an adjective base and the derivational morpheme *-mente* "-ly" (Ricca 2004).

> [[*veloce*]_A *-mente*]_{AVV} "fastly"
> [[*fragile*]_A *-mente*]_{AVV} "delicately"
> [[*rapido*]_A *-mente*]_{AVV} "rapidly"

Therefore, all the adverbs contained in the Italian dictionary of simple words have been put in a Nooj text and the FSA shown in Fig. 1 has been used to quickly populate the new dictionary by extracting the words ending with the suffix *-mente* and by making such words inherit the adjectives' polarity.

The Nooj annotations consisted in a list of adverbs that, at a later stage, has been manually checked, in order to adjust the grammar's mistakes and to add the Prior Polarity to the adverbs that did not ended with the suffixes used in the grammar (e.g. *volentieri*, "gladly"; *controvoglia*, "unwillingly").

Other mistakes concerning the annotation of the adjectives regard the adverbs that change the SO of the base adjectives (e.g. *vigorosamente*, "vigorously", and *pazzamente*, "madly", that respectively come from the positive adjective "vigorous" and the negative adjective "mad", as adverbs, become intensifiers) and also the exceptions that were not enough productive to deserve a specific path in the local grammar (e.g. adjectives ending in *-lento* that, although have the *-o* as last vowel, do not require the thematic vowel *-a-*, but the *-e-*, such as *violento* "violent" that becomes *violent-e-mente* rather than **violent-a-mente* "violenty").
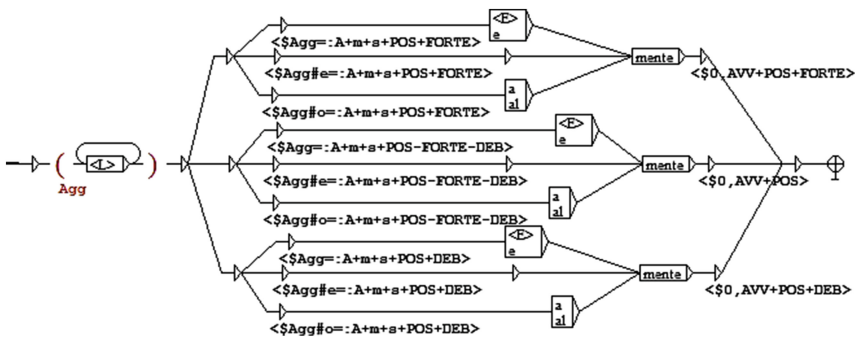

Fig. 1. Extract of the FSA for the population of the sentiment adverbs lexicon.

The manual check produced a set of 3600+ adverbs. The Precision achieved in this task is 0.99 and the Recall is 0.88.

In detail, the word recognition is anchored to the localization of an adjective stem (see the first node on the left, in the variable Agg). Then, the automaton continues the word analysis by checking that the adjective stem belongs to the sentiment dictionary (e.g. $Agg=:A+m+s+POS+FORTE).

It can be noticed, in the center of the FSA, a multiplication of paths. This depends on the different inflectional classes of adjectives on which it is attached. The rules used in the grammar to derive the adverbs are the following:

– first path: nothing in the adjective changes, e.g. *veloc-e* "fast", *veloce-mente* "fastly";
– second path: in the adjectives ending in *-re*, *-le* the *-e* is deleted [#e], e.g. *debol-e* "weak", *debol-mente* "weakly";
– third path: the *-o* is deleted [#o] and substituted by the thematic vowel *-a*, e.g. *rapid-o* "rapid", *rapid-a-mente* "rapidly".

Actually, in the FSA almost nothing about the inflection of the base adjectives has been specified. Because the adverbs of sentiment must be identified among the whole list of Nooj adverbs and semantically annotated (and not generated from scratch), we did not find necessary to recall all the inflectional classes of the derived adjectives: just the deletion or the conservation of the final vowels in the male singular adjectives (A+m+s) was used to select the correct derivational rule.

As concern the superlative form of the adverbs in *-mente*, it must be underlined that they have been treated as adverbs derived from the superlative form of the adjectives. In fact, the rule for the adverb formation is selected by the inflectional paradigm of the superlative form and not by the adjective inflection. Moreover, the semantic orientation inherited by the superlative adverb is, again, the one belonging to the superlative adjective and not the one of the adjective itself. Therefore, the superlative adverbs FSA is almost the same of the one shown in Fig. 1; the only difference is in the recognition of the base adjective, that is A+SUP rather than only A.

5   Deadjectival Nouns of Quality

Furthermore, we took advantage of other derivation phenomena connected to nouns: the derivation of quality nouns from qualifier adjectives. These kind of nouns let us treat as entities the qualities expressed by the base adjectives.

We built a morphological FSA (Fig. 2) that, following the same idea of the adverbs grammar, matches into a list of abstract nouns the stems that are in morphophonological relation with our list of hand-tagged adjectives.

Because the nouns, differently from the adverbs, include inflectional morphemes (FLX); for simplicity, we chose to associate the inflectional paradigm directly in the electronic dictionary of quality nouns suffixes (see Table 1). This way, when the FSA in Fig. 2 recalls all the syntactic properties of the nouns ($0,N$2S), the inflectional paradigms are automatically assigned to the words derived by a specific derivational morpheme.
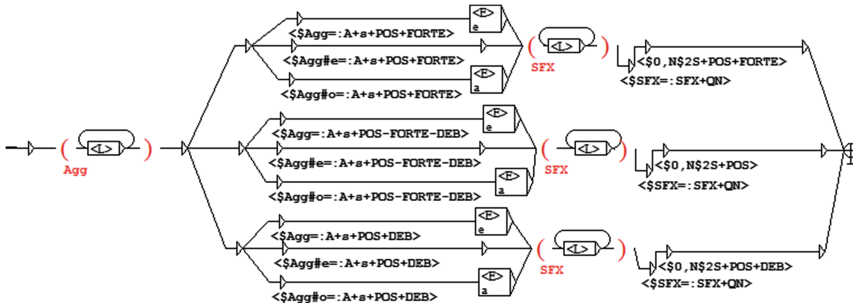
Fig. 2. Extract of the FSA for the population of the sentiment nouns lexicon

The Precision achieved in the general task is 0.93, while the Precision performances of the automatic tagging of the QN evaluated on every single suffix is summarized in Table 1.

As regards the suffixes used to form the quality nouns (Rainer 2004), it must be said that they generally make the new words simply inherit the orientation of the derived adjectives. Exceptions are *-edine* and *-eria* that almost always shift the polarity of the

Table 1. Error analysis of the automatic QN annotation

SFX	FLX	Correct	Errors	Precision
-edine	N46	0	0	–
-età	N602	0	0	–
-izie	N602	0	0	–
-ela	N41	0	1	0
-udine	N46	5	2	0.71
-ore	N5	36	9	0.80
-(z)ione	N46	359	59	0.86
-anza	N41	57	9	0.86
-itudine	N46	13	2	0.87
-ura	N41	142	20	0.88
-mento	N5	514	58	0.90
-izia	N41	14	1	0.93
-enza	N41	148	10	0.94
-eria	N41	71	4	0.95
-ietà	N602	27	1	0.96
-aggine	N46	72	2	0.97
-ia	N41	145	3	0.98
-ità	N602	666	13	0.98
-ezza	N41	305	2	0.99
-igia	N41	3	0	1
-(z)a	N41	2	0	1
Tot	–	**2579**	**196**	**0.93**

Table 2. Annotation Performances

	Precision	Recall	F-score
nouns	0.93	0.72	0.81
adverbs	0.99	0.88	0.93
average	0.96	0.8	0.87

quality nouns into the weakly negative one (−1), e.g. *faciloneria* "slapdash attitude. Also the suffix *-mento* differs from the others, in so far it belongs to the derivational phenomenon of the deverbal nouns of action (Gaeta 2004). It has been possible to use it into our grammar for the deadjectival noun derivation by using the past participles of the verbs listed in the adjective dictionary of sentiment (e.g. V:*sfinire* "to wear out", A: *sfinito* "worn out", N:*sfinimento*; "weariness"). Basically, we chose to include *-mento* in our list of suffixes because of its productivity. That caused an overlap of nouns derived by both the psychological predicates and the qualifier adjectives of sentiment.

Less than 200 psych nominalizations exceeded the coverage of our morphological FSA, proving the power of our methodology also in terms of Recall (0.72).

In about half the cases the annotations differed just in terms of intensity, the other mistakes affected the orientation also (see Table 2).

6 Morphological Semantics

Our morphological FSA can, moreover, interact with a list of prefixes able to negate (*non-, mis-, a-, dis-, in-, s-, anti-, contra-, contro-, de-, di-, es-*), to intensify (*iper-, bis-, macro-, maxi-, mega-, multi-, oltre-, pluri-, poli-, sopra-, sovra-, stra-, super-*), or to downtone (*fra-, infra-, intra-, ipo-, micro-, mini-, para-, semi-, sotto-, sub-, sur-, ultra-*) the orientation of the words in which they appear (Iacobini 2004).

If the suffixes for the creation of Quality Nouns can interact with the pre-existing dictionaries of the Italian module of Nooj, in order to automatically tag them with new semantic descriptions; the prefixes treated in this Section directly work on opinionated documents, so the machine can understand' the actual orientation of the words occurring in real texts, also when their morphological context shifts the polarity of the words listed in the dictionaries. These prefixes are endowed with special tags that specify the way in which they alter the meaning of the sentiment words with which they occur:

- FORTE: "strong", intensifies the Semantic Orientation of the words, making their polarity increase their score in the evaluation scale;
- DEB: "weak", downtones the Semantic Orientation of the words, making their polarity decrease their in the evaluation scale;
- NEGAZIONE: "negation", works following the same rules of the syntactic negation (Maisto 2014);

Figure 3 shows the morphological FSA that combines the polarity and intensity of the adjectives/adverbs of sentiment with the meaning carried on by the mCVS. The shifting rules, in terms of polarity score, are the same exploited in the syntactic

Fig. 3. FSA for the morphological contextual valence shifting

grammar net (Maisto 2014). They are summarised in the green comments on the right side of Fig. 3. As regards the manipulation of the annotations of the resulting words we followed three parallel rules:

– when the score doesn't change, the resulting word simply inherits the inflectional ($2F) and syntactic and semantic ($2S) information of the original word;
– when the intensity changes and the polarity remains steady, the resulting word inherits the inflectional and syntactic and semantic in formation of the original word, but also obtains the tags FORTE/DEB;
– when both the intensity and the polarity change, the resulting word just inherits the inflectional information, while the semantic tags are added from scratch.

We used the list of the sentiment adjectives and adverbs as Nooj text in order to check the performances of this grammar. The discovery that the words containing the mCVS lemmatised in the dictionary are very few (just 29 adjectives, e.g. *straricco*, "very rich", *ultraresistente*, "heavy duty", *stramaledetto*, "damned", and 9 adverbs, e.g. *strabene*, "very well", *ultrapiattamente*, "very dully"), increases the importance of a FSA like the one described in this Paragraph. It is also important to underline that all the synonyms of *poco* "few", also the ones that take the shape of morphemes, e.g. *ipo-*, *sotto-*, *sub-* seem not to be proper downtoners, but resemble the behaviour of the negation words that transform the sentiment words with which they occur into weakly negative ones, e.g., *ipodotato*, "subnormal" *ipofunzionante*, "hypofunctioning" (Maisto 2014). Therefore, we excluded it from the dictionary of mCVS and we included it into a dedicated metanode of the morphological FSA, able to compute its meaning in the right way.

7 Conclusion

This paper introduced a morphological strategy for the enlargement of electronic dictionaries of sentiment in the Italian language. The research has been divided into two main subtask: the semantic annotation of adverbs in -*mente* and of nouns of quality. The starting point, in both the cases, is the information connected to the adjectival bases from which new words are derived.

A large part of the contributions on sentiment lexicon expansion exploited a thesaurus based approach; while our method is morphology based. With it has been possible to automatically create, from a manually built dictionary of 5,000 sentiment adjectives, a dictionary of more than 3,200 sentiment adverbs and a dictionary of more than 3,500 nouns of quality. Moreover, we collected and used into a FSA a set of able to negate or to intensify/downtone the orientation of the words in which they appear.

Future improvement of our lexicon expansion task include the extension of the syntactic categories on which the morphological method can be applied and a systematic evaluation of the performances of the mCVS grammar on large corpora.

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