Supervised Approaches and Dependency Parsing for Chinese Opinion Analysis at NTCIR-8

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ABSTRACT

In this paper, we describe our participating system, which is based on supervised approaches and dependency parsing, for opinion analysis on traditional Chinese texts at NTCIR-8. For opinionated sentence recognition, the supervised lexicon-based approach, SVM and Maximum Entropy are combined together. For polarity classification, we use only the supervised lexicon-based approach. For opinion holder and target identification, we, on the basis of dependency parsing, identify opinion holders by means of reporting verbs and identify opinion targets by considering both opinion holders and opinion-bearing words. The results show that among all the teams participating in the traditional Chinese task, our system achieve: 1) the highest F-measure on the opinionated sentence recognition task, 2) the second highest F-measure on the identification of both opinion holders and targets, 3) the middle ranking for opinion polarity classification.

Categories and Subject Descriptors

I.2.7 [**Artificial Intelligence**]: Natural Language Processing – *text analysis*

General Terms

Algorithms, Experimentation, Languages

Keywords

Opinion Analysis, Machine Learning, Supervised Approaches, Dependency Parsing

1. INTRODUCTION

In recent years, *opinion analysis*, which mines opinions from information sources such as news, blogs, and product reviews, has drawn much attention in the NLP field [3], [17], [27], [4], [16]. It has many applications such as social media monitoring, market research, and public relations.

To analyze the opinions in news text, we first need to distinguish between opinions and facts, which could be done in the sentence level, i.e. to identify *opinionated sentences* from news articles, which is also called subjectivity classification. When an opinion is found in a sentence, it may involve different components, namely opinion expression, *opinion holder* and *opinion target* [28]. An opinion expression could be related to *polarity* (positive, negative or neutral) and intensity; an opinion holder is usually an entity that holds an opinion, and an opinion target is what the opinion is about [5], [6]. For more related work on opinion holder/target identification, please refer to [1], [2], [7], [8], [13], [19],[22], [25], [26].

The NTCIR-8 Multilingual Opinion Analysis Task (MOAT) [23] provides an opportunity to evaluate the techniques used by different participants based on a common evaluation framework in Chinese (simplified and traditional), Japanese and English, following the opinion analysis pilot task (OAPT) at NTCIR-6 in 2007 [20] and MOAT at NTCIR-7 in 2008 [21], [30], [8]. Participants need to tag opinions at a sub-sentence level and annotate the opinion features, including subjectivity, relevance, polarity, opinion holder and opinion target. More descriptions about the task are covered in the overview paper [23].

This paper describes the CityU (HK)'s system used in the traditional Chinese task at NTCIR-8 MOAT. We participated in four of the five subtasks: opinionated sentence recognition (subjectivity recognition), opinion polarity classification, opinion holder identification and opinion target identification. Three runs were submitted for the subtasks. For opinionated sentence recognition, the supervised lexicon-based approach, SVM and Maximum Entropy were combined together. For polarity classification, we just use the supervised lexicon-based approach. For opinion holder and target identification, based on dependency parsing, we identify opinion holders by means of reporting verbs and identify opinion targets by considering both opinion holders and opinion-bearing words. The results show that among all the teams participating in the traditional Chinese task, our system achieved 1) the highest F-measure on the opinionated sentence recognition task, 2) the second highest F-measure on the identification of both opinion holders and targets, 3) the middle ranking for opinion polarity classification.

The rest of this paper is organized as follows. Section 2 presents linguistic analysis of opinions. The supervised approaches to recognize opinionated sentences and to determine polarity are described in Section 3, followed by the dependency parsing-based approach for identifying opinion holders and targets in Section 4. Section 5 gives the evaluation results and finally, Section 6 concludes this paper.

2. LINGUISTIC ANALYSIS OF OPINIONS

2.1 Subjectivity and Polarity

The opinions in news text maybe explicitly mentioned, or they may be expressed indirectly by the types of words and the style of language that a speaker or writer uses [28]. Three kinds of lexical clues were exploited for opinionated sentence recognition:

1) **Reporting verbs**: verbs indicating speech events, such as 說(say), 指出(point out), 認爲 (think), etc.
2) **Sentiment-bearing items**: words/phrases bearing polarity (i.e. positive, negative or neutral), such as 好 (good), 表揚 (praise), 錯誤 (wrong), etc.
3) **Adverb clues**: adverbs frequently co-occurring with opinions, such as 可能 (perhaps), 非常 (very much), 極度 (extremely), etc.

In addition to the three kinds of clues, two other kinds were used for polarity classification:

4) **Negation marker:** words used to reverse the polarity of a polar item, such as 不 (no), 不曾(had not), 不會 (will not), etc.
5) **Discourse marker:** discourse markers that may reverse the polarity of previous clause(s), such as 雖然 (although), 不過 (but), *但是(but)*, etc.

2.2 Opinion Holders

Opinion holders are usually named entities, including person names, organization names, and personal titles. Some examples of opinion holders are as follows:

***Person Names*:** 經濟學家歐爾 (economist Ol);

Organization Names: 英國政府 (UK government);

Personal Titles: 經濟學家(economists);

Opinion holders can also be ***common noun phrases***, such as 廠商 (companies), and 兩千名學生 (two thousand students).

Pronouns can also be opinion holders, e.g. 他 (he), 他們 (they), 我(I), 你 (you), etc. Sometimes, though not very often, ***noun phrases with relative clauses*** can also be opinion holders, such as 主張蘇哈托以符合憲法方式下臺的人 (People advocating that Suharto should step down under a way complying with the Constitution).

2.3 Opinion Targets

While opinion holders usually are agents or entities who may bear opinions, opinion targets could be more abstract, including but not limited to agents, concrete objects, actions, events or even abstract ideas. Thus, opinion targets are much more diverse with respect to its forms. In addition to these forms of opinion holders, opinion targets could also be ***verb phrases*** or ***embedded clauses***. Consider the following Chinese sentence:

a) 美國、英國、法國、中共 和 俄羅斯 在 一份 廿三點 的 聲明 中 ，主張 *加强 一九七二年 的 反彈道 飛彈 條約* ，

USA, UK, France, China and Russia in a 23-points declaration, advocate *to enhance the 1972's anti-trajectory missile treaty* **,**

The opinion target in sentence a) is 加强一九七二年的反彈道飛彈條約 (to enhance the 1972's anti-trajectory missile treaty), which is a verb phrase.

Occasionally, different readers may have different views on what the holder and target are in a sentence. Consider the following sentence:

b) 但 美國 總統 布希 不 接受 這項 條約 ，嚴重 削弱 這項 條約 的 效果 ，

There can be some degree of structural ambiguity, and the sentence can be rendered into English as b.1) or b.2), because Chinese could be more free in terms of syntax.

b.1) But *that US President Bush does not accept this treaty* severely impairs the effects of this treaty.

b.2) But *US President Bush* does not accept this treaty, and *he (it)* severely impairs *the effects of this treaty*.

In sentence b.1), the opinion target could be the italicized embedded clause, while in sentence b.2) the target could be *he* in the second part referring to *美國總統布希 (US President Bush)* in the first part, or could be *這項條約的效果 (the effects of this treaty*, or even could be *這項條約 (this treaty)*.

Meanwhile, the opinion target is sometimes dependent on the choice of opinion holder. E.g. in sentence b.1), if we consider *美國總統布希(US President Bush)* is the opinion holder, the target could be *這項條約 (this treaty)*, which is different from the clause target mentioned above.

2.4 Dependency Parsing and Opinion Holders / Targets

Dependency representation provides a simple description of the grammatical relationships in a sentence [11]. It represents all sentence relationships uniformly as typed dependency relations between pairs of words. Some major dependency relations for Chinese are shown in Table 1 (Please refer to [12], [14] for more detailed description of dependency relations in Chinese).

Table 1. Some Dependency Relations in Chinese

Relation	Symbol
主谓 (Subject-Verb)	SBV
动宾 (Verb-Object)	VOB
定中 (Attributive-Noun)	ATT
数量 (Quantifier)	QUN
独立结构 (Independent structure)	IS
前附加 (Left Adjunct)	LAD

Consider the following Chinese sentence:

c) 俄國 外長 伊凡諾夫 說 ，北約 東 向 擴張 是 “ 邁向 錯誤 的 方向 ” 。

Russian Foreign Minister Ivanov said that NATO's eastward expansion was "Towards the wrong direction."

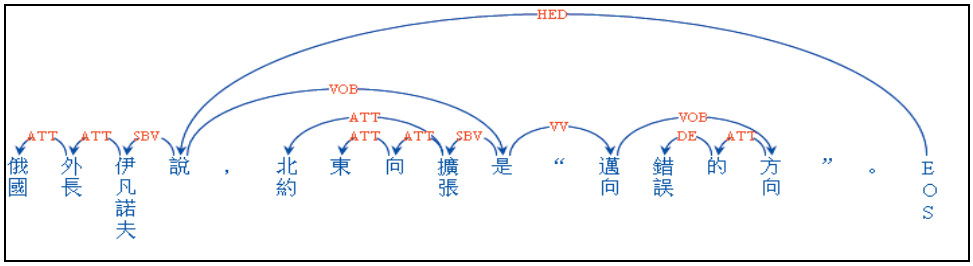

Figure 1. Dependency Tree for Sentence c)

Its dependency tree is shown in Figure 1. The head of the whole sentence is the verb 說 (said), whose subject and object are respectively 俄国外长伊凡诺夫 (Russian Foreign Minister Ivanov) and the embedded clause *北約東向擴張是"邁向錯誤的方向"*(NATO's eastward expansion was "Towards the wrong direction."). The reporting verb *說 (said)* indicates a speech event expressing an opinion given by the holder *俄国 外长 伊凡诺夫 (Russian Foreign Minister Ivanov)*. Meanwhile, the opinion-bearing word *錯誤 (wrong)* shows a negative attitude towards the opinion target *北約東向擴張 (NATO's eastward expansion)*.

Therefore, we assume that a large proportion of opinion holders are governed by such reporting verbs, while opinion targets are usually governed by opinion-bearing words/phrases.

2.5 Lexicon Preparation

Over the past years, several traditional Chinese resources of polar items have been collected for opinion analysis in our center, including NTU Sentiment Dictionary (NTUSD)[1], *The Lexicon of Chinese Positive Words* (LCPW) [24], *The Lexicon of Chinese Negative Words* (LCNW) [31], and CityU's polar word/phrase list, which were manually marked in the political news data by trained annotators from our center. Polar items manually marked with the *SENTIMENT_KW* tag (SKPI), including only positive and negative items but not neutral ones, are also extracted from the Chinese sample data of NTCIR-6 OAPT [20]. All these polar lexicons are combined to get a large lexicon[2] consisting of 13,437 positive items and 18,365 negative items, a total of 31,802 items.

The reporting verbs were firstly collected from the Chinese sample data of NTCIR-6 OAPT in which the *OPINION_OPR* tag was used to mark them, and then was extended to 308 from 68 words through manual synonym search in HowNet[3], WordNet and Tongyici Cilin [15]. Some frequently used reporting verbs include 說(say), 表示(express), 指出(point out), 認爲 (think), 强調(stress), 同意(agree), 發表(publish), etc. Some of the reporting verbs could also convey opinions, such as 批評 (criticize), 譴責 (condemn), 指責 (denounce), 讚揚 (praise), etc. There were 48 negation markers manually collected by inspection of HowNet and Tongyici Cilin, and a small set of discourse markers (i.e. 5 single markers and 7 pairs of markers) which may reverse the polarity of previous contexts were also collected [8].

[1] http://nlg18.csie.ntu.edu.tw:8080/opinion/index.html

[2] An item could be positive and negative at the same time, and we treat it as two items. For example, 防止 is marked as positive in NTUSD, and negative in SIST.

[3] http://www.keenage.com

3. SUBJECTIVITY AND POLARITY CLASSIFICATION

The motivation of our system is to make full use of both manual labeled lexicons and annotated corpora to improve opinion analysis. The combined lexicon is introduced above, and the training data includes the traditional Chinese data from NTCIR-6 OAPT and NTCIR-7 MOAT, as well as the traditional Chinese sample data from NTCIR-8 MOAT. The Chinese sentences are segmented into words using a production segmentation system. Words are treated as basic features for opinion analysis in traditional Chinese texts. The supervised lexicon-based approach and machine learning approaches, as well as the ensemble method to combine them, are described in the next subsections, respectively.

3.1 The Supervised Lexicon-based Method

For opinionated sentence recognition, the lexicons of reporting verbs and polar items mentioned above are used after adjusted on the training data. For the adjustment of lexicons, we compute the percentage of each reporting verb / polar item occurring in opinionated sentences over all sentences in the training corpus. If a reporting verb has a lower percentage than a threshold $\Theta_{reporting}$, it would be removed from the lexicon of reporting verbs. Similarly, a polar item would be removed from the lexicon of polar items, if it has a lower percentage than the threshold Θ_{polar}. We optimize Θ_{polar} and $\Theta_{reporting}$ by using a brute-force grid search within the range [0-100] (the step size is 1). More details of the training algorithm is described in [8].

There are two reasons for this adjustment: a) lexical items were collected from multiple sources which have not been cleaned, and could contain errors or typos, especially the polar items in SKPI, such as *隨着 (with)*, *可以 (be able to)*, etc.; b) these items marked by annotators with their own subjectivities could be contextual or not suitable for news domain. Two kinds of items could be filtered out during the tuning process: 1) the noisy terms which were actually not reporting verbs or polar items, e.g. 觀光 (sightseeing) in LCPW, 定下 (set) and 前往 (head for) in SKPI; 2) the reporting verbs or polar items which may present facts and frequently occur in factual sentences, e.g. 暴雨 (downpour) in NTUSD and 襲擊 (attack) in NTUSD and CPWP.

Given a segmented sentence, we check whether a polar item (including adverbs) or a reporting verb occur in it. If a sentence contains at least one item in the remaining polar item lexicon (including the adverb clues) or the reporting verb lexicon, it is reported as opinionated, otherwise not opinionated.

The adjustment process of lexicons for opinion polarity classification is similar to that for opinionated sentence recognition except that the reporting verbs are not used for

opinion polarity classification. The polar item lexicon is used together with negation markers and discourse markers. The polarity of a sentence is calculated by checking the remaining polar items. A polar item gets a score of 1 if it is marked as positive in the lexicon, -1 if negative, and 0 if both positive and negative. The scores are summed up, and the sentence is reported as positive if the sum is bigger than 0, negative if smaller than 0 and neutral equal to 0.

3.2 Machine Learning Approaches

The *opinionated sentence recognition* task is a sentence classification problem with only two labels, opinionated or not while the *opinion polarity classification* is a three-class sentence classification problem with three labels, *positive*, *negative* or *neutral*. The unigrams of Chinese words are used as the linguistic feature for machine learning.

Maximum Entropy (MaxEnt) and support vector machines (SVM) are explored. The models are trained on the training data, and then applied to classify new test data. Note these models are only used for the opinionated sentence recognition task, which is different from [8].

We constructed one feature vector for each sentence with unigrams as features and the frequency of terms as the weight of the feature, and the feature vector was normalized and then fed into the classifiers for learning. Joachim's SVM^{light} package[4] and Le Zhang's maximum entropy tool[5] are used for training and testing.

3.3 Combination

After obtaining the set of classifiers (e.g. the supervised lexicon-based classifier, SVM classifier and MaxEnt classifier), we could exploit different ensemble methods to combine the results of individual classifiers. The commonly used ensemble strategies include majority voting, sum, product, max, min, etc [18], [28]. The effectiveness of combination is determined by the diversity of its component classifiers [18].

We just used the intuitive majority voting strategy for the opinionated sentence recognition task: if two of the three component classifiers mark a sentence as opinionated, the sentence would be marked as opinionated, just like the lenient standard for evaluation.

4. IDENTIFYING OPINION HOLDERS AND TARGETS WITH DEPENDENCY TREE

This section introduces our approach of using dependency parsing to identify opinion holders/targets. For the dependency parsing, we use HITIR's NLP package[6] to parse the simplified Chinese sentences, which are converted from the traditional Chinese ones. The NLP package is developed within the simplified Chinese context, and can provide word segmentation, POS-tagging, dependency parsing and for Chinese sentences.

4.1 Preprocessing of Chinese Sentences

Since there is no space between words in Chinese, if named entities including person names, organization names, and place names within sentences cannot be identified and are split into single characters, it would be quite impossible for the parser to correctly parse the sentence. Thus, named entities are first recognized with a traditional Chinese word segmentation tool with access to the LIVAC[7]'s dictionary containing more than 1.5 million word entries collected from traditional Chinese news published in Hong Kong and Taiwan, and it should have better coverage for words and named entities in traditional Chinese news documents than the HITIR's NLP package which is developed within the simplified Chinese context. The identified named entities, as well as the collected reporting verbs and opinion-bearing words are added into the user dictionary of the HITIR's NLP package to help the Chinese parsing.

Another factor we investigated is parentheses: before parsing, the parentheses enclosing only English words or numbers are removed in sentences, because the parser cannot properly process the parentheses which may greatly influence the parsing result.

4.2 Identifying Opinion Holders with Reporting Verbs

4.2.1 Holder Candidate Generation

By intuition, we hypothesize that: 1) the subject (SBV) of reporting verbs will be the opinion holders in opinionated sentences; 2) if no reporting verb occurs in the opinionated sentences, the author could be the opinion holder. In addition to the hypothesis above, the following heuristic rules are used for opinion holder identification:

1) Other words having relations with reporting verbs

If the subject of reporting verbs is not found in the sentence, but reporting verbs occur in the opinionated sentences, we will find the word having relationship of ATT (attributive), VOB (object) or IS (independent structure) with the reporting verbs identified. The reason for this is that sometimes the parser may wrongly marked the subject (SBV) relation as other relations. Thus we use this to improve the robustness of the parser.

2) Colon processing in Headlines

In news headlines, the author of news report usually omits the reporting verb because of the length limitation of headlines, and uses a colon to denote the relation between opinion holders and opinions, and in such cases we just pick up the noun before the colons as the target candidate if no reporting verbs are found in the headlines. E.g. in the headlines *摩根*：經濟成長熄火 (*Morgan: Economic growth has been shut down*) and *印尼韋蘭托*：多次放弃政變奪權機會 (*Indonesia Vellanto: Give up the opportunity of seizing power by coups for many times*), the nouns before colons *摩根 (Morgan)* and *印尼韋蘭托 (Indonesia Vellanto)* are the opinion holders respectively.

3) Holder in the previous sentence

If no opinion holder is found in the current clause and one holder candidate is found in the previous clause, we just choose

[4] http://svmlight.joachims.org/

[5] http://homepages.inf.ed.ac.uk/lzhang10/maxent_toolkit.html

[6] http://ir.hit.edu.cn/

[7] http://www.livac.org

the opinion holder of the previous clause as the holder candidate, because an opinion holder may express several ideas by several consecutive sentences or clauses.

4.2.2 Holder Candidate Expansion

Through the procedure of candidate generation, we may find a holder candidate containing only one single word. But the holder may be a word sequence instead of a single word. Thus we further expand the holder candidates from the core head word by the following rules:

1) Attributive modifier (ATT)

E.g. in sentence a) mentioned in section 2.2, the subject of the reporting verb *說 (said)* is *伊凡諾夫(Ivanov)*, which has the attributive noun *外長 (Foreign Minister)* modified further by an attributive noun 俄國*(Russia)*. Therefore, the final extended opinion holder would be *外長伊凡諾夫(Russian Foreign Minister Ivanov)*.

2) Quantifier modifier (QUN)

E.g. the quantifier modifier *部分(some)* in the noun phrase 部分亞洲國家 (some Asian countries) should be part of the opinion holder.

3) 和/及 (and/or)

E.g. The dependency tree for the sentence *蘇哈托和另外兩名軍方將領向蘇卡諾提出...(Suharto and two other army generals addressed to Sukarno ...)* is illustrated in Figure 2. The subject of the reporting verb *提出(addressed)* is *將領 (generals)* which will be expanded to *另外兩名軍方將領(two other army generals)* after expanding by ATTs and QUNs. However, here we still need to extend the holder across *和(and)*, and the final holder is 蘇哈托和另外兩名軍方將領 (Suharto and two other army generals).

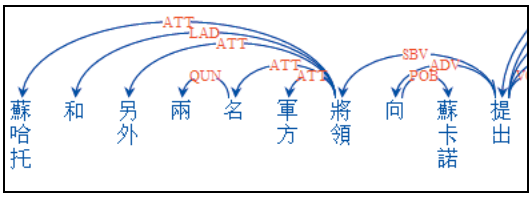

Figure 2. Dependency Tree for Sentence e)

Furthermore, time nouns, numbers and words only containing one Chinese character (except for pronouns) are removed from the candidates, as they are unlikely to be opinion holders.

4.3 Identifying Opinion Targets with Opinion-bearing Words

Here we use automatically identified opinion holders to help opinion target identification. The procedure is as follows.

1) If a candidate of opinion holder is automatically identified with a reporting verb in an opinionated sentence, we will try to find the subject in the embedded clause as the target candidate by the following two steps:

a) Find the subject of the object verb of the reporting verb. For example, in sentence a) mentioned in section 2.2, we can find *北約東向擴張 (NATO's eastward expansion)* as the subject of the embedded clause by the verb *是(was)* which is in turn the object of the reporting verb *說 (said)*.

b) If no target candidate is found in step a), we try to find a subject (SBV) whose parent is an opinion-bearing word in the latter part of the sentence after the reporting verb as the target candidate.

2) If no target candidate is found in step 1), and no opinion holder is found in the sentence, we just try to find the subject of the sentence as the target candidate, because the author may be the opinion holder and the target could be the subject of the sentence.

3) If still no target candidate is found in step 2), we just find the object (VOB) in the sentence as the target because the object could be the opinion target in case of no subject and no opinion holder in the sentence.

Target candidate expansion is similar to holder candidate expansion described in Section 4.3.2. If an opinion target is in the list of opinion holder candidates, we remove it from the target list, and then try to find another candidate.

5. RESULTS AND DISCUSSION

The above approaches were applied to the traditional Chinese task at NTCIR-8 MOAT. Standard precision (P), recall (R) and F-measure (F) were used to evaluate the performance on each subtask. More descriptions about the gold standards and metrics are covered in the overview paper [23]. All the results presented in this section were released by the organizers.

5.1 Opinionated Sentence Recognition

Three runs were submitted for this task. The first run and the third one are the same, only using the supervised lexicon-based classifier; the second run used the majority voting scheme based on three classifiers: Maximum Entropy classifier, SVM classifier, and the supervised lexicon-based classifier. Table 2 reports the performances of these three runs for this task.

Table 2. Results of opinionated sentence recognition

Run	P(%)	P(%)	R(%)
1/3	50.91	91.97	65.54
2	56.37	85.71	**68.01**

The voting scheme achieves the better performance on F-measure than the supervised lexicon-based classifier only, by improving the precision by 5.46%, but decreasing the recall by about 6.26%. Overall, our system achieved the best F-measure on this task amongst all the 14 submitted runs of the 7 participating teams, and even the supervised lexicon-based classifier achieve the third best F-measure among all runs. This result demonstrates the effectiveness of the supervised lexicon-based classifier and the ensemble method on the task of opinionated sentence recognition.

5.2 Opinion Polarity Classification

Three runs were submitted for this subtask, and they are all based on the supervised lexicon-based polarity classifier. The third run is the same with the first, and the difference between the first and the second is that 1) the first is based on the opinionated sentences in the first run for opinionated sentence recognition; 2) the second is based on those opinionated sentences in the second run for opinionated sentence recognition. Table 3 shows the results of the

three runs of polarity classification for opinionated sentences in the three runs, respectively.

Table 3. Results of opinion polarity classification

Run	P(%)	P(%)	R(%)
1/3	45.20	41.95	**43.51**
2	44.16	38.52	41.15

The supervised lexicon-based approach ranks the middle position for opinion polarity classification. It still has much room to improve.

5.3 Opinion Holder/Target Identification

Three runs were submitted for both opinion holder and target identification based on the method introduced in Section 4, which were based on the three runs for opinionated sentence recognition, respectively. The first two runs were based on the same method without the following processing: 1) *parentheses preprocessing* in section 4.1; 2) the third factor *holder in the previous sentence* in section 4.2.1; 3) the second and third points in section 4.3. The third one used all the processing and factors mentioned in section 4. The results are shown in Table 4.

Table 4. Scores for opinion holder/target identification

Run	Holder		Target	
	Strict	Lenient	Strict	Lenient
1	70.0	60.5	25.9	21.5
2	**72.1**	**62.4**	**48.5**	**41.8**
3	68.1	59.1	23.3	19.2

The second run achieved the second highest F-measure on the identification of both opinion holders and targets among all submissions, showing that the dependency parsing-based approach on opinion holder and target identification is effective. For opinion holder identification, the three runs ranked No. 3, 2 and 4 among the 8 runs submitted by 4 participating teams. For opinion target identification, the second run ranked No. 2 among the 6 runs submitted by 3 participating teams.

Please note the performance differences among the three runs were not expected to be so large beyond our expectation because the evaluation process of holder/target at Traditional Chinese side was performed manually if the proposed answer was not consistent with the gold answer. Therefore, there could be some inconsistencies due to annotators' different opinions, or errors.

6. CONCLUSION AND FUTURE WORK

This paper presents the approaches used in our system participating in the opinion analysis task on traditional Chinese texts at NTCIR-8. The system ranked No. 1 for opinionated sentence recognition, No. 2 for identification of both opinion holders and targets, the middle position for polarity classification. It shows that 1) the combination of supervised lexicon-based approach and machine learning techniques (namely, SVM and Maximum Entropy) is effective for opinionated sentence recognition; 2) the dependency parsing-based approach on opinion holder and target identification is effective despite its simplicity.

There is much room for the system to improve on opinion polarity classification. Hence part of our future work would be investigating the unique features of opinion polarity classification. The potential contribution of contextual information, topic-related features, and shallow parsing techniques would be further investigated.

Our proposed approach on identifying opinion holder/target is highly dependent on the performance of dependency parsing and is not robust to the dependency errors, we would like to further investigate machine learning approaches which can treat dependency structures as one of the linguistic features and could be more robust to dependency errors.

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