A Multilingual Polarity Classification Method using Mult-label Classification Technique Based on Corpus Analysis

Yohei Seki†
†Dept. of Information and Computer Sciences, Toyohashi University of Technology
Aichi 441-8580, Japan
seki@ics.tut.ac.jp

November 17, 2008

Abstract

In *NTCIR-7 MOAT*, we participated in four subtasks (opinion & holder detection, relevance judgment, and polarity classification) at two language sides: Japanese and English. In this paper, we focused on the feature selection and polarity classification methodology in both languages. To detect opinion and classify the polarity, the features were selected based on a statistical χ-*square tests* over *NTCIR-6* and *MPQA* corpora. We also compared several multi-label classification methods to classify positive, negative, and neutral polarity. The evaluation results suggested that the coverage of the features in Japanese was acceptable for the opinion analysis in newspaper articles, but there was still a room for improvement in the coverage of the features in English. We also found the result of *SVM voting approach* was slightly better than the results of *Multi-label classification* approach.

1 Introduction

We held a multilingual opinion analysis task twice in *NTCIR-6* and *NTCIR-7* [12, 13]. In *NTCIR-7 MOAT*, we have several different challenging points from the first one as follows:

1. The participants could use *NTCIR-6 OAT corpus*: large size test collection with detailed annotation appropriate for training use.
2. The number of participants who participated at multilingual sides with language portable approaches increased (two participants ⇒ eight participants).
3. The task focused on not only sentence-level annotation but also subsentence-level annotation.

For the first & second points, we describe our participation experience in *NTCIR-7 MOAT* at Japanese and English sides, with the approach based on the feature selection with the statistical analysis in both languages. We investigate the effective features of opinion detection and polarity classification based on χ-*square tests* over *NTCIR-6 OAT and MPQA corpora*. For opinion and holder detection, we took an *author* and *authority* classification approach [11], which was the same approach used in *NTCIR-6*, but based on the newly selected features. For polarity classification, we also compared two multi-label classification techniques: *SVM voting* and *Mulan* [16].

This paper is constructed as follows. In Section 2, we describe our methodology in *NTCIR-7*. Section 3 gives the evaluation results and discussion. Finally, we conclude our research in Section 4.

2 *TUT* Opinion Detection System in *NTCIR-7*

2.1 Overview

The opinion detection system overview in NTCIR-7 MOAT is described in Figure 1. This architecture was implemented both in Japanese and English. Our opinion detection system was based on the features selected from the significance of frequency in *NTCIR-6 OAT* and *MPQA corpora* and classified sentences into opinionated sentences expressed from author viewpoints or from authority viewpoints, as proposed in [11]. These differentiations were passed into opinion holder identification system. In relevance judgment and polarity classification system, author & authority opinions were not differentiated. In the polarity classification system, the features were also selected based on the significance of frequency in *NTCIR-6 OAT* and *MPQA corpora*.

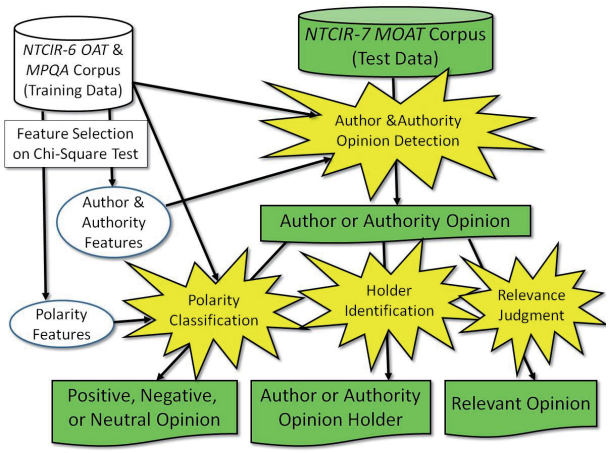

Figure 1: *TUT* System in *NTCIR-7 MOAT*

2.2 Feature selection

We selected the features for author and authority opinion detection and polarity classification based on *χ-square tests* on *NTCIR-6 OAT corpus* and *MPQA corpus* [17]. The feature examples shown in Table 3 and Table 4 were used for opinion detection and polarity classification in Japanese. The features shown in Table 5 and Table 6 were used for opinion detection and polarity classification in English. Note that the features in Japanese were suggested partially as examples due to the limit of paper space, although all the features in English were shown.

Feature selection methodology in Japanese

For author & authority opinion detection and polarity classification in Japanese, we checked the following four features:

1. The semantic primitive of the grammatical subject that was the term positioned in previous on the subject case marker "ga" (kaku-joshi) and "ha" (kakari-joshi) was abstracted using *taigen-imiso* (noun type semantic primitive) in Japanese thesaurus Bunrui-Goi-Hyou [9].

2. The semantic primitive of the action element such as verb, sahen-noun (action noun), adjective, adverb, or auxiliary verb was abstracted using *yougen-imiso* (verb type semantic primitive) in Japanese thesaurus Bunrui-Goi-Hyou.

3. All syntactically dependent clauses (*bunsetsu*) were extracted as a syntactic pair. The dependency relationship was checked using Cabocha [6] and the maximum distance of dependency was set as 2. We also extracted the pairs of the following two elements in a clause as syntactic pairs.

   (a) Normal noun (except action noun or suffix noun) or unknown word.

   (b) Verb, adjective, or action (*sahen* or *keiyoudousi*) noun, that follows the first element.

   The source element and the sink element of a syntactic dependent pair were abstracted as follows:

   (a) The source element was replaced as the following elements.

      i. The named entity tagged with Cabocha was used as a primitive in the fist priority.

      ii. If the named entity information was not tagged in the source element, *Taigen-imiso* (Noun type semantic primitive) was looked up by using the entries in *Bunrui-Goi-Hyo*.

      iii. Otherwise, a base form of the term was used. Note that the consecutive nouns were concatenated into one element.

      If a case marker was found in the element, it was also attached with the result using "=" symbol.

   (b) The sink element was replaced using *Yougen-imiso* (Verb type semantic primitive) using the entries in *Bunrui-Goi-Hyo*. The entry was also looked up by attaching "する (suru)" to action noun, which was suffix used for conversion from noun to verb in Japanese. If no entry was found, a base form of the term was used.

4. All terms with base form were extracted using morpheme tagger *Chasen* [1].

We investigated all features of these four types in the *NTCIR-6 OAT corpus* as follows.

1. In author & authority opinion detection case, if a feature appeared significantly more in the author (authority) opinion sentences than in all the other sentences, it was regarded as a useful feature for opinion detection.

2. In polarity classification case, if a feature appeared more frequently in the sentences in one polarity type (for example, positive) than sentences with other polarity types (for example, negative or neutral), it was regarded as a useful feature for polarity classification.

[1] http://chasen.naist.jp/hiki/ChaSen/

Note that the statistical significance was checked based on χ-*square test* and the significance probability of two-sided test was 5%. To avoid the error from low frequency data, we only investigated the features which appeared more than five times in the *NTCIR-6 OAT corpus*. The examples of the selected features are shown in Table 3 and Table 4.

Feature selection methodology in English

In English, the features of author and authority opinion detection and polarity classification were selected in a similar way as in Japanese. They are selected based on the analysis with χ-square test using both *MPQA* and *NTCIR-6* English corpora. We investigated the features as follows.

1. We utilized two type syntactic pairs: (a) grammatical subjects and verbs (governors), (b) auxiliary verbs and verbs. Syntactic dependency was checked using Minipar [7].
   (a) The subject element was abstracted by the following elements.
      i. If any element was not found in the *subj* position, *ZeroProN* element was assigned. Otherwise, if the antecedent was found, the subject element was replaced by it.
      ii. It was replaced by the named entities tagged using OAK [14].
      iii. It was replaced by the part of speech information tagged using OAK unless it was pronoun (*PRP*).
   (b) The verb element was abstracted by the following elements.
      i. It was replaced by the communicative verb type and attitude type in appraisal lexicon [1].
      ii. It was replaced by the four part of speech types as *SbjVerb*, *SbjAdj*, *SbjNoun*, or *SbjAdv* in the subjective lexicon [18].
      iii. Otherwise, it was replaced by the part of speech tagged with OAK.
2. Subjective term features were categorized by nouns, adjectives and adverbs, any part of speech (anypos) from the entries in the subjective lexicons [18]. The POS was filtered by OAK.
3. Subjective verb type features were abstracted as the same way in the syntactic pair feature case, but they were not replaced by the part of speech.
4. We used three count features: *cntopnoun*, *cntopadj*, and *cntopadv* that represented the numbers of the respective subjective nouns, adjectives, and adverbs in the sentence matched with the entries in the subjective lexicon [18].
5. We also used polarity term type features.
   (a) The features of adjective, adverb, or verb terms were abstracted using adjective entries [2] which contained 1,914 word entries with five polarity types as *POLP*, *POLM*, *GRAP*, *GRAM*, and *DA*.
   (b) The features of nouns were abstracted using named entity information in OAK.
   (c) If the term was not abstracted with above two methods, the term was abstracted using the General Inquirer [15] which contained 1,168 word entries with four polarity types as *IPS*, *INS*, *IPW*, and *INW*.
   (d) If term was not found in all the above lexicons, a hypernonym term using WordNet [8] was used as a feature.
6. Several other keywords was also selected as features for author and authority opinion detection.

Note that the statistical significance was checked based on χ-*square test* over both *MPQA* and *NTCIR-6 OAT* corpora. In author and authority opinion detection case, the selected features were significantly frequent in both corpora. In polarity classification case, the annotation strategy seemed slightly inconsistent in both corpora, so the selected features were significantly frequent at least in one corpus. However, if the average frequency of the features were less in the polarity sentences in one corpus even with the significantly frequent case in other corpus, they was discarded. The significance probability of two-sided test was 5%. To avoid the error from low frequency data, we only investigated the features which appeared more than five times in the *NTCIR-6 OAT corpus*. The selected features are shown in Table 5 and Table 6.

2.3 Polarity classification with multi-label classification

For polarity classification, we need to classify three labels: positive, negative, and neutral. Therefore, we need to implement multi-label classification technique. We implement the following two approaches:

1. We implemented a voting approach with three SVM classifiers: positive classifier, negative classifier, and neutral classifier. The features selected based on Section 2.2 discussion were used for each classifier. This was implemented using SVM^{light} [3] and the cost (j) parameter was tuned using sample data provided in *NTCIR-7 MOAT*.

2. We also implemented another multi-label classifier by using *Mulan* system [16], which was developed in *Aristotle University of Thessaloniki* and built on top of *Weka* [2]. Note that we could not differentiate the feature sets according to three polarity types (positive, negative, and neutral) in this classifier, so we combined them into one feature set. In *Mulan*, we can choose classfication methods such as Multi-label *k*NN classifier. After the small preliminary experiments, we decided to use *label power set classifier* in this time.

In both classifiers and in both English and Japanese languages, we used *NTCIR-6 OAT corpus* as training data.

2.4 Opinion & holder detection

The opinion detection approach was based on the combined results from author and authority opinion detection system. The author and authority opinion detection system was also implemented using SVM^{light}. The features were also selected based on the discussion in Section 2.2. The parameter tuning strategy and the training data is the same approach in the polarity classifier case.

For opinion holder identification, our architecture was based on author & authority opinion detection, as shown in Figure 2.

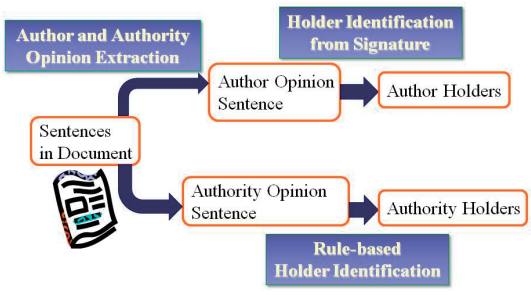

Figure 2: Opinion holder identification

Author opinion holder was extracted from author opinion sentences. For authority opinion sentences in English, based on the results of *NTCIR-6*, we followed and extended the authority opinion holder extraction approach used by the *ICU-KR* team [5] for the English side. We implemented the following opinion holder extraction rules:

1. We extracted the noun phrases that were followed by "according to".

2. We extracted the phrases that were governed by "say" or "said". If "I" was governed, the holder should be the "author".

3. We extracted the noun phrases that were followed by the word "By".

4. We extracted the phrases that were governed by the word "by".

5. We extracted the subjects governed by opinion verbs using lexicons [18] and several communicative verbs, such as "claim", "express", "announce", "talk", "tell", "note", and "deliver".

6. We extracted the interviewer or interviewee markers using heuristic rules.

7. We extracted the "person" elements from the sentence using a named entity tagger OAK[3].

2.5 Relevance judgment

For relevance judgment, our approach is the same as in *NTCIR-6 OAT* [10]. Our relevant sentence judgment was based on the cosine similarity approach using TF.IDF term weights. The target parts of speech are: self-sufficient noun, verb, adjective, and adverbs. The IDF value was based on the local document frequency, and the number of documents was computed from the documents in the test collection.

3 Evaluation

3.1 Evaluation results in *NTCIR-7 MOAT*

The *NTCIR-7 MOAT* evaluation results of opinion detection, relevance judgment, polarity classification, and holder identification at both Japanese and English sides were shown in Table 1. Note that opinion holder evaluation results were not provided in Japanese because there was no other participants in *NTCIR-7 MOAT* and evaluation was not conducted due to time constraints.

[2] http://www.cs.waikato.ac.nz/ml/weka/

[3] <http://nlp.cs.nyu.edu/oak/>

Table 1: Evaluation results in *NTCIR-7 MOAT* at Japanese and English sides

Lang	Run ID	L /S	Opinionated			Relevance			Polarity			Opinion Holder		
			P	R	F	P	R	F	P	R	F	P	R	F
J	1	L	0.6742	0.562	0.613	0.5527	0.2925	0.3825	0.4596	0.214	0.292			
J	2	L	— (same in TUT-1)			— (same in TUT-1)			0.4283	0.1994	0.2721			
J	1	S	0.5416	0.6199	0.5781	0.3062	0.3357	0.3203	0.4806	0.2417	0.3216			
J	2	S	— (same in TUT-1)			— (same in TUT-1)			0.4535	0.2281	0.3035			
E	1	L	0.3185	0.4092	0.3582	0.2092	0.1755	0.1909	0.1943	0.1830	0.1885	0.3923	0.2833	0.3290
E	2	L	0.3282	0.2562	0.2878	0.1647	0.1136	0.1344	0.1896	0.1142	0.1425	(0.3656)	(0.1689)	(0.2311)
E	3	L	— (same in TUT-1)			— (same in TUT-1)			0.1621	0.1527	0.1573			
E	1	S	0.0961	0.4149	0.1561	0.0740	0.1853	0.1057	0.0569	0.2180	0.0903	0.1250	0.2829	0.1735
E	2	S	0.1039	0.2724	0.1504	0.0615	0.1220	0.0817	0.0484	0.1185	0.0687	(0.1257)	(0.1821)	(0.1487)
E	3	S	— (same in TUT-1)			— (same in TUT-1)			0.0359	0.1374	0.0569			

3.2 Discussion

Opinion detection

For opinion detection, we were satisfied with the results at Japanese side, but were not at English side. We doubt our feature selection methodology for author and authority opinion detection might be too strict because we supposed that the selected feature should be significantly appear both in *NTCIR-6 OAT* and MPQA corpora. This caused the less number of features in English than that in Japanese, as shown in Table 3 and 5.

Polarity classification

For polarity classification, the results using *SVM voting approach* were shown as RunID 1 and the result using *Mulan classifier* was shown as RunID 2 in Japanese and as RunID 3 in English. Basically, the results of *SVM* voting approach were better than the results of *Mulan*. Note that *SVM approach* need to tune cost parameters according to each classifier and we tuned them by using sample data provided in *NTCIR-7 MOAT*, but we did not tune any parameters in *Mulan*. We concluded that these results came from that we could not discriminate the different type of features according to each polarity types in *Mulan*.

Table 2: Confusion matrix with *SVM voting* and *Mulan* approaches

	Lang	Method		Assessment (Lenient) Pos	Neg	Neu
System	J	SVM voting	Pos	15	3	51
			Neg	9	66	349
			Neu	18	52	329
			(No)	63	173	788
		Mulan	Pos	15	12	105
			Neg	16	89	346
			Neu	11	20	278
			(No)	63	173	788
	E	SVM voring	Pos	18	30	4
			Neg	64	136	18
			Neu	25	37	3
			(No)	165	318	40
		Mulan	Pos	18	17	2
			Neg	49	102	12
			Neu	40	84	11
			(No)	165	318	40

We also investigated a confusion matrix from *SVM voting* and *Mulan* as in Table 2. You could confirm that the results using *Mulan* classifier were sometimes better than the results using *SVM* classifier, for example, negative classifier in Japanese. In future, we plan to implement Multi-label classification technique to discriminate three polarity types as inputs.

Relevance judgment

Our relevance judgment approach is not trivial and simple approach. This approach proved still effective to some extent at Japanese side, but from other participant's investigation, we feel the results will improve with considering surrounding context. We assume that the low quality in English came from the different tendency of the annotation results because the human assessors annotated seemed to judge *relevant* in almost all sentences (in lenient case, more than 99%).

Opinion holder identification

For opinion holder identification, we only evaluated the results at English side. In RunID-1, we conducted the holder identification by the proposed method. In RunID-2, we also implemented the result not to differentiate author and authority opinion sentences and extract holders simply by opinion holder extraction rule, explained in Section 2.4. I also added the evaluation results of RunID-2, which is shown within brackets in Table 1, by using semi-automatic evaluation script provided from *NTCIR-7 MOAT* organizer. As a result, we found the precision of the results was not so different, but the recall decreased if we did not differentiate the author and authority sentences.

4 Conclusion

In this paper, we discussed the feature selection method based on χ-*square test* over *NTCIR-6*

OAT and *MPQA* corpora. We found that the features in Japanese were effective for opinion detection and polarity classification. In English, we also selected the slightly less features and they were also effective to some extent, but the coverage seems slightly to be limited.

We also compared *SVM voting method* and *multi-label classification technique* and found that *SVM voting approach* is slightly better with tuning cost parameter. However, the input features of multi-label classification were not differentiated according to each polarity: positive, negative, or neutral. In the next step, we plan to implement another polarity classification method by extending *multi-label classification* to utilize multiple feature sets according to polarity types as inputs.

Acknowledgments

This work was conducted when the author visited in Prof. Kathleen McKeown at Columbia University and I appreciate her precious advice for the improvements in future. Note that the author is responsible for all the results this time.

This work is partially supported by the Overseas Advanced Research Practice Support Program from the Ministry of Education, Culture, Sports, Science and Technology, Japan. This work was also partially supported by the Artificial Intelligence Research Promotion Foundation in Japan.

References

[1] K. Bloom, N. Garg, and S. Argamon. Extracting Appraisal Expressions. In *Proc. of the Human Language Technology Conf. of the North American Chapter of the Association of Computational Linguistics (HLT-NAACL 2007)*, pages 308–315, Rochester New York, USA, April 2006.

[2] V. Hatzivassiloglou and J. M. Wiebe. Lists of manually and automatically identified gradable, polar, and dynamic adjectives. gzipped tar file, 2000. [cited 2005-8-26]. Available from: <http://www.cs.pitt.edu/ wiebe/pubs/coling00/coling00adjs.tar.gz>.

[3] T. Joachims. SVM^{light} Support Vector Machine Version 6.01 [online], 2004. [cited 2005-8-26]. Available from: <http://svmlight.joachims.org>.

[4] N. Kando and D. K. Evans, editors. *Proceedings of the Sixth NTCIR Workshop Meeting on Evaluation of Information Access Technologies: Information Retrieval, Question Answering, and Cross-Lingual Information Access*, 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan, May 2007. National Institute of Informatics.

[5] Y. Kim and S.-H. Myaeng. Opinion analysis based on lexical clues and their expansion. In Kando and Evans [4], pages 308–315.

[6] T. Kudo and Y. Matsumoto. Japanese Dependency Analysis using Cascaded Chunking. In *Proc. of the 6th Conference on Natural Language Learning (CoNLL 2002)*, pages 63–69, Taipei, Taiwan, August 2002.

[7] D. Lin. MINIPAR Home Page [online], 2005. [cited 2005-8-26]. Available from: <http://www.cs.ualberta.ca/˜lindek/minipar.htm>.

[8] G. A. Miller, C. Fellbaum, R. Tengi, S. Wolff, P. Wakefield, H. Langone, and B. Haskell. WordNet [online], 2005. [cited 2005-8-26]. Available from: <http://wordnet.princeton.edu/>.

[9] National Institute for Japanese Language, editor. *Bunrui Goi Hyo*, volume 14. DainihonTosho, Tokyo, 2004.

[10] Y. Seki. Crosslingual opinion extraction from author and authority viewpoints at ntcir-6. In Kando and Evans [4], pages 336–343.

[11] Y. Seki. Opinion holder extraction from author and authority viewpoints. In *Proc. of the 30th ACM SIGIR Conf. on Research and Development on Information Retrieval (SIGIR 2007)*, pages 841–842, Amsterdam, The Netherlands, July 2007.

[12] Y. Seki, D. K. Evans, L. W. Ku, H. H. Chen, N. Kando, and C. Y. Lin. Overview of Opinion Analysis Pilot Task at NTCIR-6. In *Proc. of the Sixth NTCIR Workshop Meeting on Evaluation of Information Access Technologies: Information Retrieval, Question Answering, and Cross-Lingual Information Access*, pages 265–278, NII, Japan, May 2007.

[13] Y. Seki, D. K. Evans, L. W. Ku, L. Sun, H. H. Chen, and N. Kando. Overview of Multilingual Opinion Analysis Task at NTCIR-7. In *Proc. of the Seventh NTCIR Workshop Meeting on Evaluation of Information Access Technologies: Information Retrieval, Question Answering, and Cross-Lingual Information Access*, page (forthcoming), NII, Japan, December 2008.

[14] S. Sekine. OAK System (English Sentence Analyzer) Version 0.1 [online], 2002. [cited 2005-8-26]. Available from: <http://nlp.cs.nyu.edu/oak/>.

[15] P. J. Stone. The General-Inquirer [online], 2000. [cited 2005-8-26]. Available from: <http://www.wjh.harvard.edu/˜inquirer/spreadsheet_guide.htm>.

[16] G. Tsoumakas and I. Vlahavas. Random k-labelsets: An ensemble method for multi-label classification. In *Proc. of the 18th European Conference on Machine Learning (ECML 2007)*, pages 406–417, Warsaw, Poland, 2007.

[17] J. M. Wiebe, E. Breck, C. Buckley, C. Cardie, P. Davis, B. Fraser, D. Litman, D. Pierce, E. Riloff, and T. Wilson. MPQA: Multi-Perspective Question Answering Opinion Corpus Version 1.2, 2006. [cited 2007-1-26]. Available from: <http://www.cs.pitt.edu/mpqa/databaserelease/>.

[18] T. Wilson, J. Wiebe, and P. Hoffmann. Recognizing contextual polarity in phrase-level sentiment analysis. In *Proc. of the 2005 Human Language Technology Conf. and Conf. on Empirical Methods in Natural Language Processing (HLT/EMNLP 2005)*, Vancouver, B. C., 2005.

Table 3: Examples of Syntactic Pairs, Elements, and Keywords Clues in Author and Authority Opinion Extraction in Japanese

Feature Type	Author Clues	Num	Authority Clues	Num
"Subject"	問答 (Q & A), 交渉 (negotiation), ..	23	人物 (human), 国民・住民 (nation), ...	32
(shared)	生物 (creature), 事柄 (affair), こそあど・他 (demonstrative), 感覚 (sense), 順位記号 (symbol), ...			7
"Action"	計画・案 (plan), 見る (see), 仮定 (asuume), 意思 (intend), 判断・推測・評価 (judge, infer), 真偽・是非 (true, false, right, wrong), ...	26	表情・態度 (express, attitude), 信念・努力・忍耐 (believe, effort) , 話・談話 (speak), 予期 (expect), 授受 (give & take), 希望 (hope), ...	50
(shared)	思考・意見・疑い (think), 損得 (gain & loss), 程度 (degree), 判断 (judge), 因果 (cause), 存在 (exist), ...			22
Syntactic Pairs	PERSON – 会議・論議 (discuss), 義務 (duty)=を (wo) – 約束 (promise), 損得 (gain and loss)=を (wo) – 授受 (receive), 会議・論議 (conference) – 判断・推測・評価 (evaluate), ...	177	PERSON=は (ha) – 話・談話 (speak), PERSON=は – 賛否 (pros & cons), ORGANIZATION – 表現 (express), PERSON=は (ha) – 批評・弁解 (criticize), ...	189
(shared)	取引 (trading) - -終了・中止・停止 (stop), 未来 (future) – 詳細・正確・不思議 (detail), ...			15
Keyword	安全 (safe), 明らか (clear), たとえ (if), もちろん (of cource), 厳しい (strict), にもかかわらず (although), られる (be -ed), 要求 (request), 判断 (judgment), ...	386	高い (high), 安定 (stable), 重要 (important), いい (good), すごい (great), ほしい (want), 自由 (free), 素晴らしい (wonderful), ...	464
(shared)	おかしい (strange), 大きい (big), 必要 (necessity), ない (not), 可能 (possible), 危険 (danger),			77

Table 4: Examples of Syntactic Pairs, Elements, and Keywords Clues in Polarity Judgment in Japanese

Feature Type	Positve Clues	Num	Negative Clues	Num	Neutral Clues	Num
"Subject"	機関 (organization), 名 (name), ...	5	問答 (Q&A), 家族 (family), ...	11	経済・収支 (economy), ...	8
"Action"	思考・意見・疑い (think, opinion), 才能 (ability), 賛否 (pros & cons), 因果 (cause), 快・喜び (pleasure), 表情・態度 (expression, attitude), ...	11	脅迫・中傷・愚弄 (threat, defame), 過不足 (excess and deficiency), 威厳・行儀・品行 (dignity, manner), 恐れ・怒り・悔しさ (fear, angry),...	21	意味・問題・趣旨 (mean, issue), 呼び掛け・指図 (address, direct), 価格・費用・給与 (price, cost), 経済・収支 (economy, balance), ...	21
Syntactic Pairs	PERSON=を (wo) – 応援・送迎 (reception), 言論 (argument) – 賛否 (pros & cons), 会議・論議 (conference) – 行為・活動 (act), 詳細・正確・不思議 (detail) – 思考・意見・疑い (think), ...	49	自他 (self & others)=を (wo) – 命令・制約・服従 (order), ORGANIZATION – 救護・救援 (rescue), LOCATION=は (ha) – 批評・弁解 (criticize), 生理・病気 (disease) – 批評・弁解 (criticize), ...	35	景 (scene)=は (ha) – 詳細・正確・不思議 (detail) 経済・収支 (economy, balance) – 思考・意見・疑い (think), 人事 (human affairs) – 会議・論議 (discuss), 景 (scene)=は (ha) – 詳細・正確・不思議 (detail), ...	55
Keyword	称賛 (admire), 喜ぶ (enjoy), 満足 (satisfy), 前進 (advance), 素晴らしい (wonderful), 安定 (stable), 感動 (emotion), すごい (amazing), ...	199	ない (absent), 厳しい (strict), 難しい (difficult), 危険 (danger), 不安 (anxiety), 疑問 (interrogation), 重大 (critical), 困難 (difficulty), ...	186	必要 (necessity), 可能 (possible), ほしい (want), 不明 (unclear), 確実 (assurance), 慎重 (careful), 大切 (precious), 大事 (important), ...	170

Table 5: Syntactic Pairs, Polarity Term Lists, and Keywords Clues in Author and Authority Opinion Extraction in English

Feature Type	Author Clues	Num	Authority Clues	Num
"auxiliary verb" – "verb"	will – have cannot – *SbjVerb* can – say may – be	4	do – declare to – be could – *SbjVerb* to – *SbjVerb*	4
"subject" – "verb"	WDT – *SbjVerb* NN – say I – VB NN – VBZ *ZeroProN* – conjecture It – VBZ it – JJ *ZeroProN* – declare NNS – VBD they – VBP NNP – say WDT – VB He – say NNP – VBD it – VBZ *ZeroProN* – JJ *ZeroProN* – VB DT – VBZ *ZeroProN* – *SbjVerb* It – VB it – *SbjVerb*	21	POS – NN they – attitude NNS – *SbjVerb* IN – judgment I – declare *GPE* – VB *GPE* – VBG *ZeroProN* – *SbjAdj* I – admire We – VBP NN – *SbjVerb* he – *SbjVerb* I – *SbjVerb* NNS – attitude NNS – judgment NNP – *SbjVerb* *PERCENT* – VBD *GPE* – *SbjVerb* he – declare we – *SbjAdj* he – *SbjAdj*	28
	— — — — — — —		we – VB NNS – say they – *SbjVerb* he – judgment IN – *SbjVerb* DT – *SbjVerb* I – VBP	
(shared)	he–VBD,he–say,NN–VB,NN–*SbjAdj*			4
subjective verb type	meet,include,demonstrate,*SbjVerb*,make, prevent,appear,be,seem,SbjNoun,become,were	12	judgment,express,denied,declare,tell,characterize, admire,advise,have,apologize,voice,expand	12
(shared)	add,say			2
subjective adjective/adverb	*cntopadj*,*cntopadv*,tragic,vicious,open,worse	6	unfair,angry,firmly	3
subjective noun	*cntopnoun*,virtue,propaganda,failure,diplomacy, power,influence, enemy,doubt,right,humanity,resistance,excuse, stability	14	harassment,fear,opposition —	3
subjective anypos	must,certainly,should,merely,unfortunately, real,perhaps,rather,seem,however	10	condemn —	1
polarity term type	humaneness,education,defense,thing	4	report	1
other keywords	",content,display,perpetrate,agency,discuss	6	relationship,century,spokesman,",ministry	5

Table 6: Syntactic Pairs, Polarity Term Lists, and Keywords Clues in Polarity Judgment in English

Feature Type	Positve Clues	Num	Negative Clues	Num	Neutral Clues	Num
"auxiliary verb" – "verb"	to – promote to – attract to – set up will – continue	4	do – *SbjVerb* do – admire to – cover to – remain	4	could – *SbjVerb* to – *SbjVerb* — — — —	2
"subject" – "verb"	He – VBD I – VB I – VBN NNP – VBZ PERSON – *SbjAdj* he – VBD wood – say GPE – admire GPE – judgment I – *SbjAdj* I – VBP NN – admire NN – contribute to NN – judgment NNP – *SbjAdj* NNP – VB NNP – judgment NNP – say NNS – NN NNS – judgment PERSON – say he – *SbjAdj* he – VBZ he – judgment she – *SbjAdj* —	25	GPE – VBD NN – *SbjVerb* EX – VBD GPE – characterize GPE – say IN – characterize IN – conjecture IN – judgment JJ – VBD NN – VBD NN – characterize NN – judgment NN – say NNP – VBD NNP – VBG NNS – judgment NNS – say One – VBZ PERSON – *SbjVerb* POS – NN POS – NNP She – say WDT – *SbjVerb* WP – *SbjVerb* *ZeroProN* – judgment she – say	23	CD – VB GPE – VB GPE – attitude IN – VBZ JJ – VBZ NNP – VB We – attitude it – *SbjAdj* it – judgment we – VB we – attitude EX – NN NN – NN NN – *SbjAdj* NN – VB NN – VBZ NN – declare NNS – VB *ZeroProN* – JJ *ZeroProN* – *SbjVerb* *ZeroProN* – VB *ZeroProN* – VBG *ZeroProN* – VBZ he – *SbjVerb* it – VBZ they – VBN	26
subjective verb type	have,call,continue,play,bring,promote,strengthen,act, contribute,demonstrate,own,generate,broaden,be,admire, judgment,tell,express,contain,reduce,attract,voice,alter	22	were,advise,cover,pose,deliver,whitewash,*SbjVerb*,have, say,characterize,judgment,order,release,charge,draw, complain,plunge,gather,deem,term,notice,label,rely	23	go,put,prepare,let,stay,cope,preside, determine,catch,lift,undertake,escape, supervise,resort,be,make,declare,attitude	18
subjective adjective/adverb	*cntopadj*,able,balanced,well,wonderful,ambitious,bright, colorful,confident,cooperative,credible,exemplary,glad, grateful,great,happy,jubilant,optimistic, peaceful,pleased,popular,positive	23	controversial,harmful,negative,wrong,antiAmerican,bad, cautious,central,disadvantageous,erroneous,evil,exclusive, hardline,illegitimate,impartial,intense,leftleaning,massive, odd,opportunistic,relevant,systematic,unfair,unfounded, unpopular,unrealistic,unreasonable,wary,widespread,firmly	30	alert,essential,fair,immediate,importnat, indispensable,irrational,original, unconstitutional,vital,even,strictly,*cntopadv*	13
subjective noun	breakthrough,comment,dream,genius,peace,persistence, player,pleasure,reconciliation,remark,respect,appreciation, approval,champion,cooperation,confidence,contribution, esteem,friendship,goodwill,gratitude,hope,knock,pledge, praise,recognition,reform,resolve,restoration,significance, split,support,supporter,understanding	34	danger,impression,lack,mistake,nature,reaction,sentiment, thought,abuse,accusation,activist,anger,blame,condemnation, constraint,critic,criticism,denunciation,destruction,discontent, dissatisfaction,fear,frustration,gaffe,harm,interference ,intimidation,irregularity,motive,objection,opposition, outcry,protest,refusal,reluctance,shock,sorrow,starvation, suspicion,terrorism,threat,treason,violation,wrath,*cntopnoun*	45	discrimination,giant,harassment,need, progress,reparation,wisdom,peace	8
subjective anypos	achievement,good,really,wonderful,although, champion,grateful,sensible,show,welcome	10	claim,furthermore,seriously,wrong,against,angrily,besides, condemn,critical,disapprove,erroneous,odd,too,unreasonable	14	therefore,must,should,so,would	5
polarity term type	*IPS*,quality,inhabitant,improvement,label,phenomenon, archetypal,order,Asian,transport,orientation,maneuver, contestant,compete,association,grow,right,speech, section,imagination,northbound,*POLP*,activity, capacity,clergyman,affect,argumentation,gathering, convey,unit,continent, decrease,degree,talk, advocate, support, agreement, approval, conversation, measure, wish, drive, feeling, cooperation, knowing, anticipation,meet,capitalist,keep,acceptance, equivalent,energy,union,furniture,affair,presentation, weekday,arouse,applaud,executive	60	instrumentality,priesthood,substance,male,politician,affirm, Sinitic,note,kill,response,motion,attitude,island,damage, *INS*,express,*GRAP*,polity,state,*POLM*,organization,abstraction, government,vote,document,title,associate,composer,action, statement,coercion,judgment,charge,choice,division,care, spokesperson,race,disapproval,objection,decision,react, professional,hominid,reformer,comment,press,crime,attach, aggression,neckwear,put,anthropologist,reject,whole,hit,resident, knock,watch,designate,complain,emotion,accusation,ellipse, display,anger,beat,denial,Russian,prejudice,penetrate,poverty, weekday,encase,larceny,dismiss,disapprove,formulation, discontentment,handwear,reorient,misbehavior,disappointment	83	valuation,content,system,match,abroad, head,control,organism,duty,questioning, tract,negotiator,explanation,speculate,way, recreate,academician,flee,*INW*,normality, accessible,specify,overabundance,annoyace, complexity,evaluate,property,phenomenon, order,part,category,rede,see	33