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複数文書から抽出した言明間の意味的関係の整理と関係付与

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あらまし　我々は現在，Web 情報の信憑性評価を行うために，あるトピックに関する Web 文書集合において，さまざまな視点や角度から述べられる言明を抽出し，それらの間の類似・対立・根拠等の関係を認識して，ユーザに言明と関係の情報を提示する言論マップ生成課題に取り組んでいる．本論文では言論マップ生成のために，Web 上に存在する客観的表現や，意見などの主観的表現を扱うためには，どのような種類の意味的関係が必要であるかについて議論する．また，言明間意味的関係コーパスを構築するために我々が必要とする意味的関係を持つような用例対を Web 文書から効率よく収集する方法についても議論する．そして，言明間意味的関係コーパスを構築するためのアノテーション結果について報告し，これまでにアノテーションが終了している約 1,500 言明ペアについての評価に対する考察を行う．この言明間意味的関係コーパスは，今夏に試用版を公開する予定である．

キーワード　言論マップ生成，意味的関係，言明，意味的関係コーパス

Annotating Statement Pairs Extracted from Web Documents with Semantic Relations

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Abstract　Recognizing semantic relation is indispensable for summarizing multi-documents. In this paper, we discuss what types of semantic relations are needed to identify a variety of viewpoints on a given topic on the Web and to present these relations to users together with supporting evidence in a way that makes it clear how they are related. In order to construct a Japanese corpus, containing this information, we define semantic relations dealing with facts and opinions, and discuss how to efficiently collect valid examples and their associated semantic relations from Web documents by splitting complex sentences into fundamental units of meaning called “statements” and annotating relations at the statement level. We present an annotation scheme and examine its reliability by annotating around 1,500 pairs of statements. We are preparing the corpus for public release this summer.

Key words　Statement Map, Semantic Relations, Statement, Semantic Relation Corpus

1. Introduction

The importance of the internet as a source of information cannot be disputed. A recent poll by the Pew Research Center [9] found that among Americans the internet has overtaken newspapers as a news outlet and rivaled television for those surveyed under the age of thirty. Recent research reports that people are turning to the internet for information on important decisions like health care, medical information, and large purchases [3]; However, we must not accept as given the reliability of all information on the Web because there is a lot of incorrect information on the Web.

So, although users are at risk of believing incorrect information, they often lack the knowledge necessary to evaluate the credibility of online information [6].

To evaluate the credibility of information on the Web, it is necessary to gather sentences and summarize them, organize opinions on a topic into different viewpoints, and show users the evidence. Metzger pointed out not only the quality of description but also citing to scientific information in other Web sites, as factors to be utilized for evaluating the credibility of information on the Web [6]. Meola also indicated that comparing the focused Web information with others is able to reveal specific areas of a topic that are controversial and that need special attention and verification, and corroborating information is to verify it against one or more different sources [5] .

In this paper, we discuss how to annotate arguments for evaluating credibility of online information. In Section 2. and Section 3., we examine types of semantic relations necessary to be recognized, and carefully define each target semantic relation. In Section 4., we report an ongoing construction of a Japanese corpus of annotated statements taken from Web data. Section 6. discusses the open issues of the annotation task, and we describe availability of the corpus, and conclude in Section 7..

2. Statement Map

The goal of the Statement Map project [7] is to assist internet users with evaluating the credibility of online information by presenting them with a comprehensive survey of opinions on a topic and showing how they relate to each other. However, because real text on the Web is often complex in nature, we target a simpler and more fundamental unit of meaning which we call the "statement." To summarize opinions for the statement map users, we first convert all sentences into statements and then, organize them into groups of agreeing and conflicting opinions that show the logical support for each group.

Consider the case of an anxious user who is worried about whether vaccines are really safe for his or her child. Figure 1 shows the results of a similar query "Do vaccines cause autism?" would produce with Statement Map. The group in the upper-left is labeled [FOCUS], and it contains statements that are closest to the user's query. In this case these are opinions that support a causal link between vaccines and autism. An example is the claim "Mercury-based vaccine preservatives actually have caused autism."

The group in the upper-right is labeled [CONFLICT], and it contains statements that are in opposition to the statements of focus. This includes the counter-claim "There is no valid scientific evidence that vaccines cause autism."

The red, thick, bi-directional arrows connecting the [FOCUS] and [CONFLICT] groups help that opposition in opinion stand out to the user. It is clear that these are strongly opposing opinions. The groups labeled [EVIDENCE] at the bottom of the figure contain supporting evidence for the [FOCUS] statements and [CONFLICT] statements. They are linked by thin, gray, mono-directional arrows.

For example, a user who is concerned about potential connections between vaccines and autism would be presented with a visualization of the opinions for and against such a connection together with the evidence supporting each view as shown in Figure 1.

When the concerned user in our example looks at this Statement Map, he or she will see that some opinions support the query "Do vaccines cause autism?" while other opinions do not, but it will also show what support there is for each of these viewpoints. So, Statement Map can help user come to an informed conclusion.

3. Semantic Relations between Statements

3.1 Recognizing Semantic Relations

To generate Statement Maps, we need to analyze a lot of online information retrieved on a given topic, and Statement Map shows users a summary with three major semantic relations.

[AGREEMENT] to group similar opinions
[CONFLICT] to capture differences of opinions
[EVIDENCE] to show support for opinions

Identifying logical relations between texts is the focus of Recognizing Textual Entailment (RTE). A major task of the RTE Challenge [1] is the identification of [ENTAILMENT] or [CONTRADICTION] between Text (T) and Hypothesis (H). For this task, several corpora have been constructed over the past few years, and annotated with thousands of (T,H) pairs.

While our research objective is to recognize semantic relations as well, our target domain is text from Web documents. The definition of contradiction in RTE is that T contradicts H if it is very unlikely that both T and H can be true at the same time. However, in real documents on the Web, there are many examples which are partially contradictory, or where one statement restricts the applicability of another like in the example below.

(1) a. Mercury-based vaccines actually cause autism in children.
b. Vaccines can trigger autism in a vulnerable subset of children.

While it is difficult to assign any relation to this pair in an RTE framework, in order to construct statement maps we need to recognize a contradiction between (1a) and (1b).

There is another task of recognizing relations between sentences, CST (Cross-Document Structure Theory) which was developed by [10]. CST is an expanded rhetorical structure analysis based on RST [15], and attempts to describe relations between two or more sentences from both single and multiple document sets. The CSTBank corpus [11] was constructed to annotate cross-document relations. CSTBank is divided into clusters in which topically-related articles are gathered. There are 18 kinds of relations in this corpus, including [EQUIVALENCE], [ELABORATION], and [REFINEMENT].

3.2 Facts and Opinions

RTE is used to recognize logical and factual relations between sentences in a pair, and CST is used for objective expressions because newspaper articles related to the same topic are used as data. However, the task specifications of both

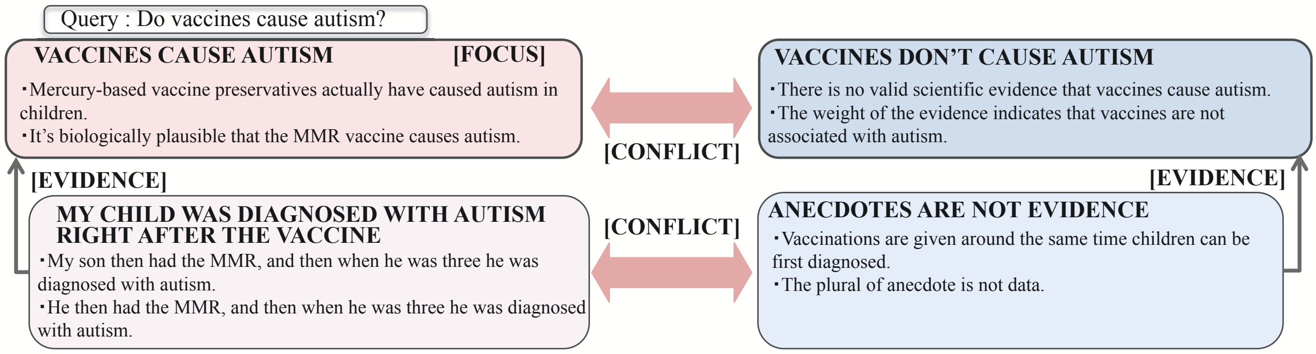

Figure 1: An example Statement Map for the query "Do vaccines cause autism?"

RTE and CST do not cover semantic relations between opinions and facts as illustrated in the following example.

(2) a. There must not be a connection between vaccines and autism.
b. I do believe that there is a link between vaccinations and autism.

Subjective statements, such as opinions, are recently the focus of many NLP research topics, such as review analysis, opinion extraction, opinion QA, or sentiment analysis. In the corpus constructed by the MPQA Project (Multi-Perspective Question Answering) [14], individual expressions are marked that correspond to explicit mentions of private states, speech events, and expressive subjective elements.

Our goal is to annotate instances of the three major relation classes: [AGREEMENT], [CONFLICT] and [EVIDENCE], between pairs of statements in example texts. However, each relation has a wide range, and it is very difficult to define a comprehensive annotation scheme. For example, different kinds of information can act as clues to recognize the [AGREEMENT] relations. So, we have prepared a wide spectrum of semantic relations depending on different types of information regarded as clues to identify a relation class, such as [AGREEMENT] or [CONFLICT]. Table 1 shows the semantic relations needed for carrying out the anotation. Although detecting [EVIDENCE] relations is also essential to the Statement Map project, we do not include them in our current corpus construction.

3.3 Approaches to collecting examples

The [EVIDENCE] relation class in Table 1 is able to be recognized by performing rhetorical structure analysis on a document, while other relations can be detected by analyzing arbitrary sentences derived from separate documents. We believe that examples of [EVIDENCE] should be collected from a document using discourse structures, because several discourse markers used in a document explicitly show cause, grounds, such as [EVIDENCE]. When we need to consider [EVIDENCE] between sentences in different documents, we first identify [EVIDENCE] between sentences in the same document, and then extend this to cross document [EVIDENCE] relation by detecting [AGREEMENT] between sentences in different documents.

Consider the [EVIDENCE] between a statement (1), and (2a) and (2b) in another document.

(1) There was more evidence refuting the MMR vaccine-autism link.

(2a) There is no link between the MMR vaccine and autism.

Table 1: A typology of semantic relations for generating a statement map

Relation Class	Relation Label
AGREEMENT	Equivalence
	Equivalent Opinion
	Equivalent Evaluative Polarity
	Specific
	Similar
CONFLICT	Conflict
	Confinement
	Conflicting Opinion
	Conflicting Evaluative Polarity
EVIDENCE	Evidence

(2b) Because finally special federal court ruled.

The relation [EVIDENCE] can be recognized between these two sentences (2a) and (2b), since "Because" is found as a discourse maker by rhetorical structure analysis, and [AGREEMENT] can be recognized between (1) and (2a) with existing RTE methods. Finally, [EVIDENCE] is detected between (1) and (2b) by these two recognized relations. We decided to collect the examples of [EVIDENCE] relation by using annotation of discourse structure, and we will construct another corpus with [EVIDENCE] relation separately.

To construct our corpus, we focus on two semantic relation classes, [AGREEMENT] and [CONFLICT]. Table 1 shows all semantic relations for our task, and it consists of relation classes and labels.

4. Constructing a Japanese Corpus

4.1 Targeting Semantic Relations Between Statements

Real data on the Web generally has complex sentence structures. That makes it difficult to recognize semantic relations between full sentences. but it is possible to annotate semantic relation between parts extracted from each sentence in many cases. For example, the two sentences A and B in Figure 2 cannot be annotated with any of the semantic relations in Table 1, because each sentence include different types of information. However, if two parts extracted from these sentences C and D are compared, the parts can be identified as [EQUIVALENCE] because they are semantically close and each extracted part does not contain a different type of information. So, we attempt to break sentences from the Web down into reasonable text segments, which we call "statements." When a real sentence includes several pieces of semantic segments,

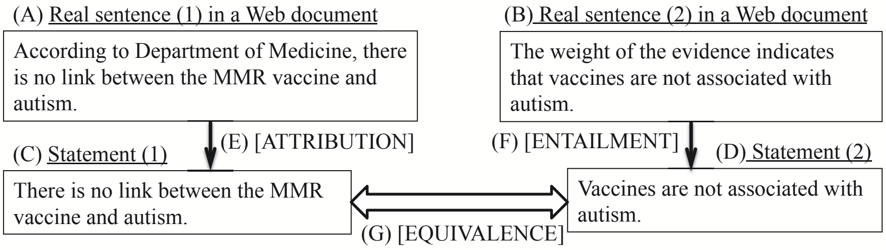

Figure 2: Extracting statements from sentences and annotating a semantic relation between them

more than one statement can be extracted. So, a statement can reflect the writer's affirmation in the original sentence. If the extracted statements lack semantic information, such as pronouns or other arguments, human annotators manually add the missing information. Finally we label pairs of statements with either one of the semantic relations from Table 1 or with "NO RELATION," which means that two sentences (1) are not semantically related, or (2) have a relation other than relations defined in Table 1.

4. 2 Structure of the corpus

The structure of an entry in the corpus is represented by the 5-tuple as shown in Figure 2.

Real sentences (A) and (B). These are real sentences extracted from original Web documents.

Statements (C) and (D). When a real sentence includes several pieces of semantic segments, more than one statement can be extracted. So, a statement can reflect the writer's affirmation in the original sentence. If the extracted statements lack semantic information, such as pronouns or other arguments, human annotators manually add the missing information.

Entailment/Attribution flags (E) and (F). If a substantial substring match can be found between a sentence and a statement, then we annotate them as either [ATTRIBUTION] or [ENTAILMENT]. The difference is illustrated in the following examples where keywords such as "according to" are used to identify when a statement is an [ATTRIBUTION].

Semantic relation label (E) in Figure 2. Each pair of statements is labeled with a semantic relation from Table 1 or with "NO RELATION."

4. 3 Corpus Construction Procedure

We automatically gather sentences on related topics by following the procedure below:

(1) Retrieve documents related to a set number of topics using a search engine [12]

(2) Extract real sentences that include major sub-topic words which are detected based on TF or DF in the document set

(3) Reduce noise in data by using heuristics to eliminate advertisements and comment spam

(4) Reduce the search space for identifying sentence pairs and prepare pairs, which look feasible to annotate.

For example, "regulation", "research" or "possibility" were selected as sub-topic words for a given query "clone technology".

Next, we describe how we prepared the sentences pairs. In CSTBank, a document cluster consists of several news articles. Annotators checked every pair of sentences between all articles, and identify the relations to an arbitrary pair of sentences when a relation they found. It is not much of a burden for annotators to prepare a pair, because the news articles were related to a specific event and the number of articles is not so large.

Table 2: Statistics of the semantic relations

Relation Class	Relation Label	number	ratio
AGREEMENT	Equivalence	141	0.094
	Equivalent Opinion	12	0.008
	Equivalent Evaluative Polarity	41	0.027
	Specific	576	0.383
	Similar	92	0.061
CONFLICT	Contradiction	26	0.017
	Confinement	32	0.021
	Conflicting Opinion	29	0.019
	Conflicting Evaluative Polarity	39	0.026
NO RELATION	No Relation	517	0.344
	Total	1505	1.000

In our annotation task, however, the document set is quite bigger than the clusters in CSTBank, and the content-relatedness of each document in the set is uncertain because the documents are related by only sharing given queries. It is clear the majority of the sentence pairs which are randomly selected are invalid, because they do not share similar kinds of information, and they can not be explicitly annotated with any semantic relation. So, we have to try to (1) reduce the search space for identifying pairs of sentences and (2) prepare pairs, which look feasible to annotate. It is quite important to relieve the burdens of the annotators.

Dolan et.al proposed a method to narrow the range of sentence pair candidates and collect candidates of sentence-level paraphrases which correspond [EQUIVALENCE] in [AGREEMENT] class in our task [2]. It worked well for collecting valid sentence pairs from a large cluster which was constituted by topic-related sentences. The method also seem to work well for [CONFLICT] relations, because lexical similarity based on bag-of-words (BOW) can narrow the range of candidates with this relation as well.

We calculate the lexical similarity between the two sentences based on BOW.We also used hyponym and synonym dictionaries [13] and a database of relations between predicate argument structures [4] as resources. According to our preliminary experiments, unigrams of KANJI and KATAKANA expressions, single and compound nouns, verbs and adjectives worked well as features, and we calculate the similarity using cosine distance. We did not use HIRAGANA expressions because they are also used in function words.

5. Analyzing the Corpus

Five annotators annotated semantic relations according to our specifications in 22 document sets as targets. We have an-

Table 3: Definition of semantic relations and example in the corpus

Relation Label	Descriptions	Examples in English and Japanese
Relation Class : AGREEMENT		
Equivalence	Both A and B is TRUE at the same time	A: The overwhelming evidence is that vaccines are unrelated to autism. B: There is no link between the MMR vaccine and autism. A:クローン技術は，優れた遺伝子を持つ動物，固体をたくさんコピーできる B:クローン技術を使用することで，すぐれた動物と同一の遺伝子をもつコピーを作ることができる
Equivalent Opinion	Different sources are in agreement or their opinions entail one another	A: We think vaccines cause autism. B: I am the mother of a 6 year old that regressed into autism because of his 18 month vaccinations. A: クローン技術によって人個体を産生することはいろんな問題があって，これは規制をする方がいい B: クローン技術によるヒトクローン個体作製は禁止すべきである
Equivalent Evaluative Polarity	A and B evaluate something from different perspectives and their opinions have the same polarity	A: Vaccines are not effective. B: We think vaccines cause autism. A: ステロイド剤は，使い方によっては副腎皮質機能不全になります B: ステロイド剤は，副作用として骨が脆くなって，骨粗鬆症の様な症状が出る場合がある
Specific	Both A and B share the same information, and B has additional information	A: Mercury-based vaccine preservatives actually have caused autism in children. B: Vaccines cause autism. A: 従来からのアトピー治療は「ステロイド剤」によるものである B: アトピーの治療は湿疹を抑えるため，ステロイド剤の外用を行います
Similar	A and b have similar sentence structure	A: MMR can cause autism. B: Mercury-based vaccines can cause autism. A: 消炎鎮痛剤は炎症を抑えます B: ステロイド剤は，炎症を抑える効果がある
Relation Class : CONFLICT		
Contradiction	Both A and B cannot be TRUE at the same time	A: Mercury-based vaccine preservatives actually have caused autism in children. B: Vaccines don't cause autism. A: やけどに対して，ステロイド剤がよく効きます B: やけどに対して，ステロイド剤は危険性があるうえに，効果がない
Confinement	B confines the situations in which A applies	A: Vaccines can trigger autism in a vulnerable subset of children. B: Mercury-based vaccine actually have caused autism in children. A: ステロイド剤は驚くほどの効果がある B: ステロイド剤は強さ，範囲，使い方さえ守れば，十分な効果がある
Conflicting Opinion	Different sources disagree or their opinions are contradictory	A: I don't think vaccines cause autism. B: I believe vaccines are the cause of my son's autism. A: クローン技術の応用の可能性は非常に大きく，今後も研究の推進が重要である B: クローン人間の研究は法律で禁止すべきだ
Conflicting Evaluative Polarity	A and B evaluate something from different perspectives and their opinions have opposite polarities	A: We think vaccines cause autism. B: Vaccines are very important to protect our kids from dangerous diseases like measles. A: クローン技術によるヒト胚の操作には問題がある B: 人に対するクローン技術の研究によって助かる人がたくさんいる
Relation Class : No Relation		
No Relation	There is no relation between A and B, or the relation cannot be classified into a known category	A: In the UK, confidence in vaccines collapsed. B: Parents should realize that a choice not to get a vaccine is not a risk-free choice. A: アトピー性皮膚炎はステロイド剤の副作用でステロイド皮膚症に移行する B: ステロイド剤では，症状は楽になるものの，治癒や長期の寛解は期待できません

notated target statement pairs with either [AGREEMENT], [CONFLICT] or [NO RELATION]. We provided 2,303 real sentence pairs to human annotators, and they identified 1,375 pairs as being invalid and 928 pairs as being valid. The number of annotated statement pairs are 1,505 ([AGREEMENT]:862, [CONFLICT]:126, [NO RELATION]:517). Table 2 shows the detail of the each semantic relation.

Next, to evaluate inter annotator agreement, 207 randomly selected statement pairs were annotated by two human annotators. The annotators agreed in their judgment for 81.6% of the examples, which corresponds to a kappa level of 0.49. The annotation results are evaluated by calculating recall and

Table 4: Inter-annotator agreement for 2 annotators

		Annotator A			
		AGR.	CON.	NONE	TOTAL
	AGR.	146	7	9	162
Anno-	CON.	0	13	1	14
tator B	NONE	17	4	10	31
	TOTAL	163	24	20	207

precision in which one annotation result is treated as a gold standard and the other's as the output of the system, as shown in Talbe 4.

6. Discussion

The number of sentence pairs that annotators identified as invalid examples shows that around 60% of all pairs were invalid, showing that there is still room to improve our method of collecting sentence pairs for the annotators. Developing more effective methods of eliminating sentences pairs that are unlikely to contain statements with plausible relations is important to improve annotator efficiency. We reviewed 50 such invalid sentence pairs, and the results indicate two major considerations: (1) negation, or antonyms have not been regarded as key information, and (2) verbs in KANJI have to be handled more carefully. The polarities of sentences in all pairs were the same although there are sentences which can be paired up with opposite polarities. So, we will consider the polarity of words and sentences as well as similarity when considering candidate sentence pairs.

In Japanese, the words which consist of KATAKANA expressions are generally nouns, but those which contain KANJI can be nouns, verbs, or adjectives. Sharing KATAKANA words was the most common way of increasing the similarity between sentences. We need to assign a higher weight to verbs and adjectives that contain KANJI, to more accurately calculate the similarity between sentences.

Another approach to reducing the search space for statement pairs is taken by Nichols et.al [8], who use category tags and in-article hyperlinks to organize scientific blog posts into discussions on the same topic, making it easier to identify relevant statements. We are investigating the applicability of these methods to the construction of our Japanese corpus but suffer from the lack of a richly-interlinked data source comparable to English scientific blogs.

7. Conclusion

In this paper, we described the ongoing construction of a Japanese corpus consisting of statement pairs annotated with semantic relations for handling web arguments. We designed an annotation scheme complete with the necessary semantic relations to support the development of statement maps that show [AGREEMENT], [CONFLICT], and [EVIDENCE] between statements for assisting users in analyzing credibility of information in Web. We discussed the revelations made from annotating our corpus, and discussed future directions for refining our specifications of the corpus. We are planning to annotate relations for more than 6,000 sentence pairs in this summer, and the finished corpus will consist of around 10,000 sentence pairs. The first release of our annotation specifications and the corpus will be made available on the Web(1) this winter.

(1)：http://cl.naist.jp/stmap/corpus/ja

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