

A Method for Abstracting Newspaper Articles by Using Surface Clues

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Abstract

This paper describes a system which automatically creates an abstract of a newspaper article by selecting important sentences of a given text. To determine the importance of a sentence, several superficial features are considered, and weights for features are determined by multiple-regression analysis of a hand processed corpus.

1 Introduction

The rapid expansion of the Internet enables us to easily access a lot of information sources in the world. The ability to browse information quickly is therefore a very important feature of an information retrieval and navigation system. Abstraction of a document is one useful tool for quick browsing of textual information.

Generally, an abstract can be considered to be a concise text giving an outline of the original text. Creating an abstract requires deep semantic processing with broad knowledge, and the strategy for generating an abstract depends on the type of target text. Abstracts created by humans tend to differ according to their creators' background knowledge and interests. Furthermore, as stated in [6], the same person is likely to create different abstracts of the same text at different times. Simulating this human process is clearly outside the area that can be dealt with by current computational linguistics. There are, however, some cases in which an abstract can be created by using surface clues to make conjectures as to which portions are the most important without using deep semantic processing.

The most practical way to create an abstract is thus to determine the most important portions by using surface clues. There are two lines of research based on this approach: one analyzes some aspects of a text's structure, such as the rhetorical structure [7], and selects

some sentences according to this structure [5, 3]; the other analyzes surface features for each sentence in a given text and selects the most important sentences according to some heuristics [6, 1, 9]. In methods of former type, the rhetorical structure is appropriate for a relatively small set of sentences such as a paragraph, but it does not give enough information to create an abstract for a large set of sentences. In methods of the latter type, the validity of the heuristics is uncertain when the target text is changed. Therefore, this paper proposes a method for selecting important sentences by using an equation based on surface features and their weights, and a method for determining these weights by multiple-regression analysis of abstracts created by humans. The target texts of this method are Japanese newspaper articles.

2 Surface Features of a Sentence

The proposed method is to create an abstract by determining important sentences according to features extracted from each sentence. For each sentence in a given Japanese newspaper article, the following features¹ are analyzed:

- Important Keywords:

An important keyword is defined as a keyword that appears in another sentence or in a title. The number of points for this feature is the total number of occurrences of important keywords.

- Tense:

The tense of a sentence is analyzed as *past* or *present*. This feature gives 1 point for *present*, and 0 for *past*.

¹Most of these features were proposed in the previous studies. Keywords were proposed in [6], sentence location was proposed in [1], sentence type was proposed in [1, 9], etc., and rhetorical relations were proposed in studies using rhetorical structures such as [3].

- **Type of a Sentence:**
Sentence types are *fact*, *conjecture*, or *insistence*. This feature gives 0 points for *fact*, 1 for *conjecture*, and 2 for *insistence*.
- **Rhetorical Relation:**
The rhetorical relations to the preceding context is analyzed as *example*, *adverse*, *parallel*, *comparison*, or *connection*. This feature gives 1 point for *reason*, 2 for *example*, and 0 for others.
- **Distance from the beginning of a text:**
In general, sentences located near the beginning of a text tend to be important. Therefore, sentences in the first paragraph are given 5 points for this feature, sentences in the next paragraph 4, and so on.
- **Distance from the end of a text:**
Sentences located near the ending of a text also tend to be important. Therefore, sentences in the last paragraph are given 5 points for this feature, sentences in the previous paragraph 4, and so on.

The tense of a sentence is simply determined to be *past* if it has “ta” (an inflection for the past tense) in the last phrase.² The reason why tense is used is that sentences stating about the current fact seem to be more important than ones about the past fact in the context of editorial articles.

The sentence type is determined by checking special expressions in the last phrase.³ For instance, if the final phrase contains “bekida” (“should”) or “nakerebanaranai” (“must”), then its sentence type is *insistence*; if it contains “darou” (“probably ...”), then its type is *conjecture*; otherwise, its type is *fact*. Examples of special expressions used to determine sentence type are as follows:

- **Conjecture:** *kamosirenai* (may), *kanenai* (be capable of), *souda* (likely to), *youda* (likely to), *darou* (probably), etc.
- **Insistence:** *tai* (want to do), *hosii* (want someone to do), *bekida* (should), *nakereba-naranai* (must), *taiyetu-dearu* (important), *hituyouda* (necessary), etc.

²In this method, *past* does not imply the past tense in a strict sense but rather the sentence is not in the present tense. In Japanese, “ta” implies the past tense, completion, and so on. Most cases are actual instances of the past tense.

³It is sufficient to check in the last phrase for Japanese sentences, because a predicative phrase is always located at the end of a Japanese sentence. Therefore, another strategy is needed for languages in which a predicative phrase may be located in the middle of a sentence.

The rhetorical relation is determined by checking special expressions both in the first phrase and in the last phrase of a sentence. For instance, if “sitakarada”⁴ is found in the last phrase, then the rhetorical relation is *reason*, and if the conjunction “sikasi” (“but”) is found, then the rhetorical relation is *adverse*.⁵ Examples of special expressions used to determine rhetorical relations are listed below:

- **Example:** *tatoeba* (for instance), *nado* (etc.), etc.
- **Adverse:** *sikasi* (but), *tokoroga* (however), etc.
- **Comparison:** *koreni-taisi* (while), etc.
- **Parallel:** *mata* (further), *sarani* (in addition), etc.
- **Reason:** *karada* (because), *tameda* (because), etc.

3 Process of Creating an Abstract

The basic method for creating an abstract in most previous studies has been to analyze the sentences of a text in terms of some surface features, and a heuristic to determine the most important sentences on the basis of these features.

The method proposed in this paper formalizes the above approach so that the importance of each sentence is calculated as the sum of feature points multiplied by their feature weights. The most important sentences are then extracted as an abstract. The importance S of a sentence is calculated as follows:

$$S = a + \sum_{i=1}^n W_i * P_i$$

where a is a constant, P_i is the number of points assigned to the i -th feature, which is normalized to be between 0 and 1, and W_i is the weight assigned to the i -th feature.

The steps in creating an abstract are as follows:

1. For each sentence, calculate the importance.
2. Select the sentence that has the highest importance value among the unselected sentences.
3. If the selected sentence s_1 has another sentence s_2 in the previous context that is related to s_1 by any rhetorical structure, then s_2 is also selected and marked.

⁴In English, this expression corresponds to “because” in the first phrase.

⁵These checking of sentence types and rhetorical relations are based on [10].

- If the ratio of the number of selected sentences to the number of sentences in the text exceeds the specified one, then terminate this process; otherwise, goto 2.

These steps select sentences on the basis of their importance value, but they also respect the rhetorical structure to some extent (step 3), because if the rhetorical structure is totally ignored, the output text will be awkward to read.

4 A Method for Determining the Weights of Features

Most previous systems can be considered to determine the weights of features according to human intuition. On the other hand, this paper proposes a method for determining the weights of features by multiple-regression analysis of correct examples, which are abstracts created by testers. A tester selects important sentences that should be included in an abstract. The importance value of a sentence is defined as the number of supporters (testers who selected it as an important one) divided by the total number of testers. Let this importance value be S ; we then get the following equation for each sentence:

$$S = a + \sum_{i=1}^n W_i * P_i$$

where, a is a constant, P_i is the number of points assigned to the i -th feature which is normalized to be between 0 to 1, and W_i is the weight assigned to the i -th feature.

In this equation, W_i is the only variable. Therefore, the feature weight W_i is calculated by multiple-regression analysis.

5 Experiment

We conducted an experiment to check the validity of the proposed method.

The testers were divided into two groups, A and B, each consisting 10 people. Those in group A selected important sentences (about 1/3 of the article) in 5 editorials and 3 general articles from the Nikkei Newspaper. Those in group B selected important sentences (about 1/3 of the article) in 3 editorials and 3 general articles, which were different from those used for group A. One of the editorials and one of the general articles

Feature	General Article		Editorial Article	
	Weight Set 1	Weight Set 2	Weight Set 1	Weight Set 2
Constant	0.0	0.183	0.0	0.039
Keyword	1.0	0.216	1.0	0.151
Tense	0.3	-0.180	0.3	0.046
Type	0.3	-0.331	1.0	0.089
Relation	-1.0	0.127	-1.0	-0.279
Location (Beginning)	1.0	0.437	1.0	0.242
Location (Ending)	1.0	-0.015	1.0	0.214

Table 1: Weight Set of Features (General and Editorial Articles)

used for group B are shown in Figures 1 (a) and 2 (a), respectively. In each of these figures, the first number is a sentence number, the second number is the number of supporters in group B, and the last part is a rough English translation.⁶

Table 1 shows two weight sets; weight set 1 was created by the author in such a way that sentences located near the beginning and end are regarded as important, sentence importance is not proportional to points for rhetorical relation, and the importance of *insistence*-type sentences is higher in editorials than in general articles.⁷ Weight set 2, on the other hand, was calculated from the results obtained from group A by the method described in the previous section. Weight set 2 for general articles implies that sentences near the beginning are more important than ones near the end, and *insistence*-type sentences are less important, and so on. On the other hand, weight set 2 for editorials implies that sentences both near the beginning and near the end are important, and that *insistence*-type sentences are important.⁸

To check the validity of these weight sets, we compared the abstracts created by the system, using weight set 1 and 2, from the articles supplied to group B, with

⁶This translation was made by the author, and is not authorized by Nikkei Newspaper K.K.

⁷This weight set 1 corresponds to the way used in previous studies, where weights are determined according to human intuition.

⁸The weight set calculated in this method can be used as basic material for creating a practical system, because it is difficult to ask enough people to do this experiment to ensure that the result is statistically meaningful. However, the general tendency can be extracted, and the weight set is determined on the basis of this experiment.

the abstracts created by group B. For the general article in Figure 1 (a), the three most important sentences (roughly 1/3 of the article) determined by using the weight sets 1 and 2 are listed in Figures 1 (b) and (c), respectively. In this case, the three most important sentences selected by group B were 0, 2, and 3. Likewise, for the editorial in Figure 2 (a), the eight most important sentences (roughly 1/3 of the article) determined by using weight sets 1 and 2 are listed in Figures 2 (b) and (c), respectively. In this case, the eight most important sentences selected by group B are 0, 2, 3, 12, 15, 20, 21, 22. Here, we introduce the following metric of estrangement to check which abstract is most similar to the result of group B:

$$\text{Estrangement} = \sum_{s_i} (\text{the number of supporters of a sentence } s_i) - \sum_{s_j} (\text{the number of supporters of a sentence } s_j)$$

where s_i is a sentence that is included in an abstract by group B but not in an abstract created by the system, and s_j is a sentence that is not included in an abstract by group B but is included in an abstract created by the system.

The estrangements of the articles in Figures 1 and 2 are as follows: From this result, the weight set 2 calcu-

Fig.	Weight Set 1	Weight Set 2
1	14	6
2	13	12

lated by multiple-regression analysis is more similar to the human selection than the weight set 1 created according to the author's intuition. For the other general articles used with group B, the estrangement values of weight set 2 are also better than those of weight set 1. In the other editorials, the estrangement values are comparable. This implies that the weight set 1 is not such a bad estimate for editorials.

6 Discussion

So far, most systems for creating an abstract of a text has been selected important sentences by some heuristics on the basis of surface features. However, most of these heuristics were derived from human intuition, and the validity of them are uncertain if the target text is changed. As mentioned in the introduction, the strategy of an abstraction should be changed according to the given text. Therefore, it is needed

to adjust these heuristics for the given text. This paper proposed a method for this adjustment; that is, a method for determining weights of surface features by multiple-regression analysis of abstracts created by human. By using this method, a system can have an ability to be applied to a variety of texts.

7 Conclusion

This paper has proposed a method for creating an abstract by using surface features and their weights to select important sentences, and a method for determining these feature weights by multiple-regression analysis of abstracts created by humans. By using the proposed method to calculate feature weight, this system can be applied to other types of texts, and gives results more similar to those of a human process than a set of weights based on human intuition.

This abstract creation system is currently used in an information navigation assistance system [8] as a tool for quickly viewing the contents of newspaper articles.

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Title: 最新鋭MPU搭載パソコン、IBM、来夏発売——低価格・高速処理を実現。(IBM to release PC equipped with the latest MPU, featuring low cost and fast processing)

0 (10) 【ニューヨーク10日=松本元裕】米IBMは十日、最新鋭マイクロプロセッサ（MPU、超小型演算処理装置）「パワーPC」を搭載したパソコンを来年夏に発売することを明らかにした。(IBM Corporation announced on the 10th of this month that a personal computer equipped with the latest "PowerPC" microprocessor will be released next summer.)

1 (3) まずノート型を発売、続いてデスクトップ型二機種を投入する。(First, a notebook PC will go on sale; this will be followed by two types of desktop PC.)

2 (5) 低価格で処理速度の高いパワーPCは、IBM再生のカギを握ると言われるコンピューターの心臓部品。(The "PowerPC" is used as a central part of a computer. It is cheap and has high processing power, and is said to be a key to IBM's recovery.)

3 (9) 同社がパワーPC搭載パソコンの商品計画を明らかにしたことで、他の日米欧のパソコン各社も対抗策を迫られることになりそうだ。(Since IBM announced its plan to sell personal computers equipped PowerPCs, other PC makers in the world are likely to take countermeasures.)

4 (3) 発売する三機種はCD-ROM、マイク、ステレオオーディオ、音声認識機能を標準装備して、マルチメディア機能を高める計画。(The above three types of PC will provide additional multimedia functions by including CD-ROM, microphone, stereo audio, and voice recognition functions as standard features.)

5 (0) OS（基本ソフト）はIBMの「OS/2」のほか、米マイクロソフトの「ウィンドウズNT」、サン・マイクロシステムズの「ソラリス」などにも対応できるようにする。(IBM's OS/2, Microsoft's Windows NT, and Sun Microsystems' Solaris will be installed as operating systems.)

6 (0) パワーPCはIBM、アップルコンピュータ、モトローラの三社が共同開発したRISC（縮小命令セットコンピューター）型MPU。(PowerPC is a RISC-type MPU developed by IBM, Apple, and Motorola.)

7 (2) パソコン用MPU市場で事実上の標準機種になっているインテル製MPUに対抗するための商品で、低価格・高速処理が特徴だ。(It is intended to compete with Intel CPUs, which are de-facto standards in the PC microprocessor market. Its main advantages are low price and fast processing.)

8 (1) パソコン業界二位のアップルがパワーPC搭載パソコンを来年発売する計画を発表。(The second largest PC maker, Apple, has announced a plan to release a "PowerPC"-based PC next year.)

9 (0) 同一位のIBMはパワーPC内蔵のワークステーションをすでに発売しているが、パソコンについては製品計画を明らかにしていなかった。(The largest PC maker, IBM, has already released a PowerPC-based workstation, but has not announced any corresponding plan for PCs.)

10 (1) IBMはパワーPCを外販するだけでなく、搭載パソコンの技術仕様を外部に有償で公開、パワーPC搭載パソコンのファミリー作りを進める計画。(IBM plans to sell PowerPCs to other vendors, license the technology, and create a family of PowerPC-based PC.)

11 (3) アップルなどと合わせたパワーPC搭載パソコン全体で、世界の市場に占めるシェアを最低二〇%程度までもっていきたい考え。(Together with Apple and others, IBM aims to gain at least a 20% share in the PC market for PowerPC-based PC.)

(a) Original Article

2 (5) 低価格で処理速度の高いパワーPCは、IBM再生のカギを握ると言われるコンピューターの心臓部品。

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(b) Abstract by Weight Set 1

0 (10) 【ニューヨーク10日=松本元裕】米IBMは十日、最新鋭マイクロプロセッサ（MPU、超小型演算処理装置）「パワーPC」を搭載したパソコンを来年夏に発売することを明らかにした。

1 (3) まずノート型を発売、続いてデスクトップ型二機種を投入する。

2 (5) 低価格で処理速度の高いパワーPCは、IBM再生のカギを握ると言われるコンピューターの心臓部品。

(c) Abstract by Weight Set 2

Fig. 1: An Example of Abstract of General Article (Nikkei Newspaper, 1 Nov. 1993)

Title: 「経済難民」締め出しを決めたドイツ（社説）(Germany determined to shut out economic refugees.)

0 (10) ドイツの議会が基本法（憲法）を改正して、貧困など経済的理由による外国人の移住を認めないことにした。(The German Diet has revised the constitution to prohibit immigration for economic reasons such as poverty.)

1 (3) 受け入れは政治亡命に限り、いわゆる経済難民を締め出そうというわけだ。(The aim of this move is to shut out economic refugees and accept only political refugees.)

2 (8) 理想主義の後退は残念だが、重い財政負担、ドイツ社会の現状などから見て、やむを得ない措置といえよう。(This retreat from idealism is disappointing, but in view of the current situation of Germany, it is an inevitable measure.)

3 (6) 七月から実施する規制措置は、「迫害のない国」（ルーマニア、ブルガリア、ハンガリーなど）からの亡命を除いて受け入れず、政治亡命を認めている「安全な第三国」（西欧とポーランド、チェコの計十八カ国）を経由してきた難民は経由国に送り返す、というものだ。(The restriction, which will come into effect in July, will prohibit refugees from "countries without persecution" (e.g. Romania, Bulgaria, and Hungary) from being granted entry except in special cases, and will repatriate political refugees through "safe countries" (e.g. western European countries, Poland, and Czechoslovakia) which permit political refugees.)

4 (1) 東欧革命などで民主主義体制に転換した国々から政治亡命者が出るはずがないという論理である。(The logic behind this is that there cannot be political refugees from countries that have been converted into democratic nations by the East European Revolution, and so on.)

5 (2) 第二次大戦後の一九四九年に制定された基本法の第一六条二項は「政治的に迫害された者は庇護（ひご）を受ける権利がある」と規定し、亡命者に寛大だった。(Clause 2, Article 16 of the Basic Law established after WWII, in 1949, was generous to refugees stating that people persecuted politically had a right to be protected.)

6 (0) これは、ナチ時代の排外主義が他民族に危害を加え、ドイツからも多くの移民を生み出したことに対する反省に基づいている。(It was based on the reflection that anti-foreign policies in the 'Nazi' era had hurt foreign nations and produced many refugees from Germany.)

7 (0) 社会主義国家の存在を強く意識して、この理想主義的な条項をつくったともいう。(It is also said that this clause was created out of strong consideration for socialist states.)

8 (2) だが、ドイツが統一され、東西冷戦が終わると、状況は一変した。(However, Germany's situation has been totally changed by the unification of Germany and the end of the cold war.)

9 (1) 昨年一年間で西欧主要国に流入した難民は申請ベースで七十五万人に達し、規制が緩いドイツは四十四万人と全体の六割を超えた。(The number of refugee applicants arriving in major Western European countries last year reached 700,000, among whom the

number arriving in Germany, which has loose restrictions, was 440,000, over 60% of the total for Europe.)

10 (0) この四月には四万三千人がドイツに亡命を申請し、四万一千人が審査を受けたが、亡命を認められたのは七百人だけだった。(43,000 people applied to Germany for refugee status this April; of these, 410,000 were interviewed but only 700 were accepted.)

11 (0) 申請者の七三％はルーマニア、旧ユーゴスラビアなど旧ソ連・東欧からの人々で占められる。(73% of applicants are from Eastern Europe or ex-soviet-bloc countries such as Romania, and former Yugoslavia.)

12 (0) 一方で、不法入国も後を絶たない。(At the same time, there is a constant flow of entrants.)

13 (5) ドイツはいま、戦後最悪とも言える不況下にある。(Germany is now said to be suffering the worst recession since WWII.)

14 (0) 旧西ドイツ地域の失業率は四月で七・一％だが、経済再建が遅れている旧東ドイツ地域は一四・七％と高い。(The unemployment rate in April was 7.1% in former West Germany, and 14.7% in former East Germany.)

15 (1) 極右勢力による外国人襲撃など排外的な風潮が強まっているのは、大量に流入してきた外国人が自分たちの職を奪うのでは、という不安があるからだ。(There is a growing anti-foreign tendency manifested in attacks on foreigners by ultra-rightist groups, resulting from anxiety that masses of immigrants will take native people's jobs.)

16 (4) 難民はいったん、収容施設に入り、審査が終わるまでそこで暮らす。その費用負担が各州や市町村に重くのしかかっている。(Refugees enter government-provided accommodation and live there until their interviews are completed, with their expenses borne by states and cities.)

17 (2) このため、多くの地方政府は難民規制を強く働きかけていた。(For this reason, many regional governments have appealed for the numbers of refugees to be restricted.)

18 (0) 西欧各国並みの難民規制を設けようという基本法の改正には、連立与党各党のほか、野党・社会民主党の議員の多くも賛成した。(Most Diet members in coalition government parties and social liberalist party approved the revision of the Basic Law, which imposes restrictions on refugees similar to those of other major Western European countries.)

19 (3) 戦後処理、冷戦の後始末という意味あいもあり、ドイツにとってひとつの時代が終わったという印象を受ける。(The move is also intended to be a post-war process and the settlement after the Cold War, and gives the impression of the end of an era in Germany.)

20 (0) フランスなど他の西欧各国も経済難民の規制強化に踏み切っている。(Other major Western European countries such as France have also decided to impose more restrictions on economic refugees.)

21 (4) 貧しい国の人々が豊かな国へ行こうとするのは自然の成り行きだが、大量の移動は混乱と摩擦を生む。(It is natural for poor people to try to go to rich countries, but the movement of many people produces confusion and friction.)

22 (7) 国際協力で経済難民が発生する素地をなくすことがより重要であり、西欧各国が一定の制限を設けるのもやむを得まい。(It is important to alleviate the conditions that produce economic refugees through world-wide cooperation, and it may be inevitable for European countries to impose some level of restricts.)

23 (5) ただ、これらの例をそのまま、国情や環境が違う日本に当てはめて考えるのは問題があろう。(However, it is not appropriate to apply these examples to Japan, because Japan's circumstances are different from those in Europe.)

(a) Original Article

0 (10) ドイツの議会が基本法（憲法）を改正して、貧困など経済的理由による外国人の移住を認めないことにした。

1 (3) 受け入れは政治亡命に限り、いわゆる経済難民を締め出そうというわけだ。

2 (8) 理想主義の後退は残念だが、重い財政負担、ドイツ社会の現状などから見て、やむを得ない措置といえよう。

3 (6) 七月から実施する規制措置は、「迫害のない国」（ルーマニア、ブルガリア、ハンガリーなど）からの亡命は例外を除いて受け入れず、政治亡命を認めている「安全な第三国」（西欧とポーランド、チェコの計十八カ国）を経由してきた難民は経由国に送り返す、というものだ。

18 (0) 西欧各国並みの難民規制を設けようという基本法の改正には、連立与党各党のほか、野党・社会民主党の議員の多くも賛成した。

20 (0) フランスなど他の西欧各国も経済難民の規制強化に踏み切っている。

21 (4) 貧しい国の人々が豊かな国へ行こうとするのは自然の成り行きだが、大量の移動は混乱と摩擦を生む。

22 (7) 国際協力で経済難民が発生する素地をなくすことがより重要であり、西欧各国が一定の制限を設けるのもやむを得まい。

(b) Abstract by Weight Set 1

0 (10) ドイツの議会が基本法（憲法）を改正して、貧困など経済的理由による外国人の移住を認めないことにした。

1 (3) 受け入れは政治亡命に限り、いわゆる経済難民を締め出そうというわけだ。

2 (8) 理想主義の後退は残念だが、重い財政負担、ドイツ社会の現状などから見て、やむを得ない措置といえよう。

3 (6) 七月から実施する規制措置は、「迫害のない国」（ルーマニア、ブルガリア、ハンガリーなど）からの亡命は例外を除いて受け入れず、政治亡命を認めている「安全な第三国」（西欧とポーランド、チェコの計十八カ国）を経由してきた難民は経由国に送り返す、というものだ。

4 (1) 東欧革命などで民主主義体制に転換した国々から政治亡命者が出るはずがないという論理である。

20 (0) フランスなど他の西欧各国も経済難民の規制強化に踏み切っている。

21 (4) 貧しい国の人々が豊かな国へ行こうとするのは自然の成り行きだが、大量の移動は混乱と摩擦を生む。

22 (7) 国際協力で経済難民が発生する素地をなくすことがより重要であり、西欧各国が一定の制限を設けるのもやむを得まい。

(a) Abstract by Weight Set 2

Fig. 2: An Example of Abstract of Editorial
(Nikkei Newspaper, 1 Jun. 1993)