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Summarization of the Methodology of Applying N-gram to Obtain Factor Scores of Q&A Statements

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Abstract

With a view to solving the troubles of mismatches between the questioners and respondents of Question and Answer (Q&A) sites, an impression evaluation experiment resulted in obtaining nine factors of impressions for Q&A statements. Factor scores were then estimated through multiple regression analysis utilizing feature values of statements. The factor scores obtained and estimated were subsequently employed for finding appropriate respondents who would be likely to answer a posted question. However, this methodology so far has substantially depended on the syntactic information extracted through morphological analysis. In addition, this method has a significant drawback of demanding manifold variables and complex multiple regression equations to estimate factor scores. Thus, another course has been taken by applying N-gram instead of morphological analysis. So far, the analyses of 2-gram through 5-gram have shown good estimation accuracy. In order to strengthen these tendencies, in this paper, 6-gram is applied to the feature values. Further analysis has shown that 6-gram would also be applicable to the method. In terms of estimation accuracy, N-grams also outscore morphological analysis; above all 2-gram and 3-gram show the best accuracy. Hence, it could be suggested that N-gram should play a more important role in estimating factor scores than mere morphological analysis.

Keywords: Factor score, Multiple regression analysis, N-gram, Q&A site

1 Introduction

Recently, there have been increasing numbers of people registering and using Question and Answer (Q&A) sites, which are the communities where questions and answers are manually posted, e.g. Yahoo! Chiebukuro (Y!C) [1]. These Q&A sites are looked on as immense databases which include huge amounts of knowledge to resolve miscellaneous matters or issues. The primary process of a Q&A system is as follows: a question is posted by a user, and then may be responded by others, regardless of contents or accuracy of their responses. Among the answer statements posted, the questioner subjectively selects the most satisfying and appropriate one as the "Best Answer" (BA).

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However, with increasing numbers of registered users and posted questions at Q&A sites, it will be harder for respondents to catch sight of the questions that meet with their specialty and interests. Therefore, qualified respondents may not notice a question suitable for their tastes. Additionally, while Q&A sites are getting accepted as the collective knowledge for society, inappropriate answers can also be accumulated. Thus, failing to encounter any appropriate respondents could give rise to various mismatches and issues. For example, incorrect answers can provide wrong knowledge. The shortage of necessary knowledge to appropriately solve the question might eventually leave it unsolved. Additionally, abusive words, slander, or statements against public order and standards of decency could be offensive to readers.

Therefore, in order to stock appropriate answer statements, it would be vital to demand respondents to be able to provide appropriate answers. For the purpose of solving the issues described earlier, there have been abundant prior works researching Q&A sites [2-9] using textual features or link analysis. However, these works have not taken the tendencies of the written styles of users into consideration. Additionally, it would be awkward to say that a methodology of introducing appropriate respondents to a questioner has been established yet. Hence, by utilizing impressions of statements, the objective of the present work is to introduce appropriate respondents to a questioner. The growth of the work will contribute to accumulating more appropriate answer statements and make Q&A sites more beneficial to society, eventually bring about the rapid and effective promotion of social activities. This work thus aims to present questions to users who are qualified to give appropriate answers to them, resulting in eradication of the problematic issues stated above.

As an initial phase of the work, through factor analysis applied to the experimental results, nine factors that indicate the impression of Q&A statements were obtained [10]. Factor scores were then estimated through multiple regression analysis employing the 77 feature values of statements [11]. This initial method, however, was considerably dependent on the syntactic information (Syn-Info) extracted through morphological analysis (MA), one form of syntactic analysis. Besides, considering quadratic terms yields immense explanatory variables (EVs), leading to obtaining highly complex multiple regression equations to estimate factor scores. Therefore, as an alternative syntactic analysis, N-gram can take place of Syn-Info [12-14]. In running multiple regression analysis, the feature values based on N-gram and those other than the Syn-Info were jointly employed as EVs, while the factor scores of their respective nine factors were set as respondent variables [12-14]. So far, the analysis results using 2-gram through 5-gram have shown that, for all these factors, the estimation result using N-gram as well as MA has been similar to or better than that using mere MA [12-14]. In addition, unlike the previous method utilizing MA where the quadratic term was needed for better estimation accuracy, monadic terms alone would be sufficient for estimating factor scores and could simplify the analysis result with far fewer EVs [12-14].

In order to ensure that ╞N-gram would be applicable with longer units, in this paper, 6-gram is applied and analyzed in a similar fashion as the 2-gram [12], 3-gram [12], 4-gram [13] and 5-gram [14]. As a matter of convenience, 2-gram, 3-gram, 4-gram and 5-gram are collectively designated as previous N-grams in this paper. Similar to the prior analysis with previous N-grams, the feature values based on 6-gram and those other than the Syn-Info are integratedly set as Evs through multiple regression analysis, while the scores of nine factors are used as respondent variables. Further analysis has shown that 6-gram would also be applicable to the methodology. Similar to the previous N-grams, 6-gram also outperformed MA ~~as well~~ in terms of estimation

accuracy. As a whole, it has been shown that N-gram would be more effective than MA in applying N-gram instead of Syn-Info to estimate factor scores.

The rest of this paper is composed of the following: section 2 introduces related works; section 3 summarizes the estimation of factor scores using morphological analysis; section 4 explains estimating factor scores utilizing previous N-grams (N=2, 3, 4 and 5) ; section 5 provides multiple regression analysis using 6-gram; section 6 discusses considerations toward the analysis results; and finally, section 7 concludes the paper.

2 Related Works

Among a diversity of previous studies in the literature investigating Q&A sites, regarding merely introducing users to answer statements. Riahi *et al.* surveyed the method to provide appropriate experts with a newly posted question [2]. Profiles were constructed according to their answering history and then employed through several measures. For some of the dataset, their proposal model showed good performance in recommending new questions to experts. Harper *et al.* sought for predictors of answer quality through a comparative and controlled field study of responses provided across several online Q&A sites [3]. The comparison analysis has shown that each Q&A site had individual tendencies and features about user contributions to the sites. Haq *et al.* have researched the Q&A site reputation through Quora, a Q&A platform that integrates elements of social networks to the traditional Q&A model [4]. Their demonstration has shown that stronger subjectivity might lead to more extreme polarity, due to the self-experience argued in the anonymous content. Jurczyk and Agichtein used link analysis to detect users who were authorities for specific question categories [5]. They regarded the difference between positive/negative evaluation for answers rated by other users, the proportion of answer statements chosen as BAs, and the rate value when selected as a BA by the questioner. Their analysis result has shown good precision for a portion of the categories. Wang *et al.* proposed an approach that includes user topical interest, and expertise based on historical Q&A [6]. They also built a calculation method of users' activeness based on historical questions, answers, and comments. According to their evaluation result, their proposed method has shown best performance in respondent recommendation under a certain condition. Anandhan *et al.* adopted the "Tag Relationship Expert Recommendation to identify the tag relationship among users [7]. Their analysis result has shown that their proposed method outperforms the existing baseline methods by effective improvement of the performance of relevant dominant experts. In order to solve unsolved questions, Yazdaninia *et al.* investigated the effectiveness of various features to solve an unsolved question by utilizing several predictive models so that it can be predicted whether a question will get an accepted answer or not [8]. Gao *et al.* proposed a neural network-based approach to identify the most reliable answer through three-phase process; question boosting, label establishment, and answer recommendation [9]. As a result of their analysis, their approach was considerably better than existing baselines in automatic evaluation.

Although these prior works have developed their research employing link analysis, tags, and so on, the tendencies of answer statements have not been taken into consideration. Some users might tend to write in a polite tone, while others might prefer to respond in a ruder style. Some are commonly inclined to use abstract words, whereas others prefer to express themselves in concrete phrases. Meanwhile, this work focuses on using impressions in addition to textual features. Moreover, in spite of several previous studies that introduce users to answer statements as

summarized [2-9], a methodology to introduce appropriate respondents to a questioner has yet to be established. Hence, by using the impression of statements, the purpose of this work is to introduce appropriate respondents to a questioner.

3 Estimation of Factor Scores Using Syntactic Information

3.1 Obtaining Factors of Statements

This work was inaugurated with an impression evaluation experiment in order to evaluate impressions of answer statements. Forty-one evaluators joined the experiment and were asked to rate the style or content of statements and assign five-level labels from a list of 50 impression words [10]. The experimental materials were chosen from those actually posted at Y!C [1] in 2005 [10]. These were twelve sets of Q&A statements consisting of the respective three sets from four categories: Auction, PC, Love, and Politics.

Factor analysis was then performed to the experimental results to obtain factors. The factors represent the nature of a statement, as interpreted through the several impression words allocated to the statement. These factors were named accuracy, displeasure, creativity, ease, persistence, ambiguity, moving, effort, and hotness. The factor scores were also calculated to use in representing the characteristics of Q&A statements.

3.2 Estimation Result

At the point of impression evaluation experiment explained in Section 3.1, factor scores were obtained for a mere sixty Q&A statements utilized as the experimental materials. Therefore, in order to be able to obtain factor scores of any Q&A statement, the next principle is to estimate the scores from feature values of statements through multiple regression analysis. The detailed explanation of the feature values are summarized in Appendix A. Based on 77 monadic EVs, 281 quadratic terms were set as explanatory variables, while factor scores for the nine factors were employed as respondent variables. From the viewpoint of multiple correlation coefficients (MCCs), which indicate the estimation accuracy, all the nine factor scores show good estimation result because MCCs were bigger than 0.9 for all the nine factors as shown in Table 1 [11].

Table 1: Multiple Correlation Coefficient (MCC): MA [6]

Factor		MCC (MA)
1st	(Accuracy)	1.000
2nd	(Displeasure)	0.947
3rd	(Creativity)	0.877
4th	(Ease)	0.908
5th	(Persistence)	0.966
6th	(Ambiguity)	0.899
7th	(Moving)	0.997
8th	(Effort)	0.904
9th	(Hotness)	0.954

4 Estimation of Factor Scores Using N-gram

4.1 Aim

The initial methodology summarized in Section 3.2 has considerably relied on the Syn-Info extracted through MA. Furthermore, enormous explanatory variables (EVs) could be attributed to requiring quadratic terms and might result in highly complex multiple regression equations employed for estimating factor scores. Meanwhile, N-gram is known as an alternative syntactic analysis of MA. Therefore, with a view to lower computational cost, N-gram could play a similar role in estimating factor scores. In addition, applying N-gram could possibly lead to better estimation accuracy and produce more concise equations to calculate factor scores. Therefore, as the flow chart ~~shown~~ in Figure 1 shows, N-gram is applied to the methodology utilizing Syn-Info summarized in Section 3. As an initial step of applying N-gram, the following principles are applied to estimating factor scores using N-gram [12-14].

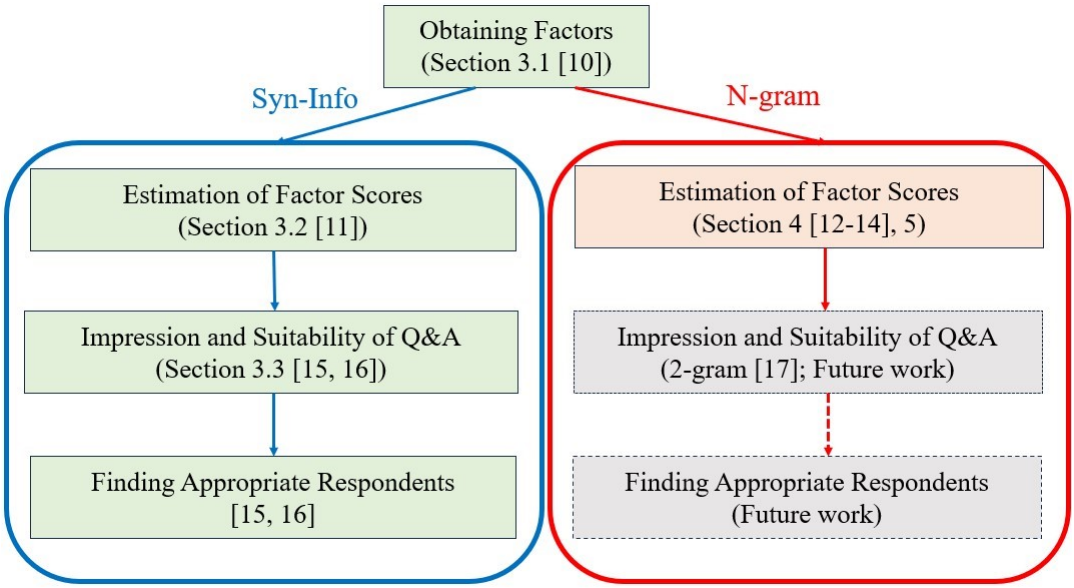

Figure 1: Flow chart of the methodology

4.2 N-gram

In this subsection, the explanation of N-gram will be provided before the analysis using N-gram. Similar to MA, N-gram is also known as another method of syntactic analysis. N-gram is the adjacent sequence of N units of characters, morphemes, or Part-of-Speeches (PoSs). Here, N must be set to an arbitrary integer at least 2 [18]. One question statement out of the sixty experimental materials is utilized to show an N-gram PoS. In this example, this question statement is denoted as "QA04" for convenience. Owing to brief explanation, 2-gram PoS is focused on. The original Japanese question statements of QA04 and their English translations are summarized in Table 2. As an example of the 2-gram PoS, their PoS, examples in Japanese, and frequencies are shown in Table 3. The column entitled "2-gram" represents both literal notations and abbreviations. The notations "Noun," "Verb" and "Sign" indicate as they are, while those "Adjective," "Particle," "Auxiliary," and "Adverb" are abbreviated as "Adj," "Part," "Aux" and "Adv," respectively. Taking an example of the notation [Noun - Part] shown in the first row, the 2-gram

consists of a noun and a particle. This provides one respective example per 2-gram extracted from QA04 as shown in the column entitled “Example (Japanese).” The column entitled “Frequency” shows the appearance time of each 2-gram.

Table 2: Original Japanese Statements of QA04 and Their English Translations [12-14]

QA04	Statements
Japanese (Original)	パソコン初心者です。デジカメで撮った画像を プリントアウトしたところ画像が暗いのですが、明るくする方法をご存知の方回答をお願いします。
English (Translation)	I am a beginner of using computers. I have printed out images I took with a digital camera, but they turned out dark. If anybody knows how to make them brighter, please answer my question.

Table 3: 2-gram and Frequency for QA04 [12-14]

2-gram	Example (Japanese)	Frequency
[Noun - Part]	[画像 - を]	6
[Part - Noun]	[の - 方]	4
[Noun - Noun]	[パソコン - 初心者]	4
[Verb - Aux]	[する - ます]	3
[Aux - Sign]	[ます - 。]	2
[Aux - Noun]	[た - ところ]	2
[Noun - Aux]	[初心者 - です]	2
[Noun - Verb]	[お願い - する]	2
[Sign - Adj]	[、 - 明るい]	1
[Sign - Noun]	[。 - デジカメ]	1
[Adj - Verb]	[明るい - する]	1
[Adj - Noun]	[暗い - の]	1
[Part - Sign]	[が - 、]	1
[Part - Adj]	[が - 暗い]	1
[Part - Verb]	[で - 撮る]	1
[Aux - Part]	[です - が]	1
[Verb - Noun]	[する - 方法]	1

4.3 Analysis Method of Applying N-gram

In applying N-gram PoS, the cases when N was set to 2 through 5 have been analyzed instead of Syn-Info [12-14]. Here, feature values of N-gram were applied and extracted according to the sixty Q&A statements used for the experiment described in Section 3.1. Here, a statistical programming R [19] was executed to obtain the feature values of N-gram. In performing R, the library entitled RMeCab was installed to run N-gram on top of MA.

Similar to the prior analyses stated in Section 3.2, multiple regression analysis was performed in order to obtain factor scores of the nine factors, which were set as respondent variable. On the other hand, as for explanatory variables (EVs), the feature values to be used are illustrated in Figure 2. As shown in Figure 2, feature values of N-gram (Ngr_1-Ngr_17) replace Syn-Info (g1-g36) based on MA. The amount of feature values of N-gram has been tentatively set at 17 through trial and error. The detailed feature values of N-gram are summarized in Appendix B. Combined with WI (g37-g38), Closings (g39-g64), WF (g65-g71), NV (g72-g77) and N-gram (Ngr_1-Ngr_17), these 68 feature values were used as EVs.

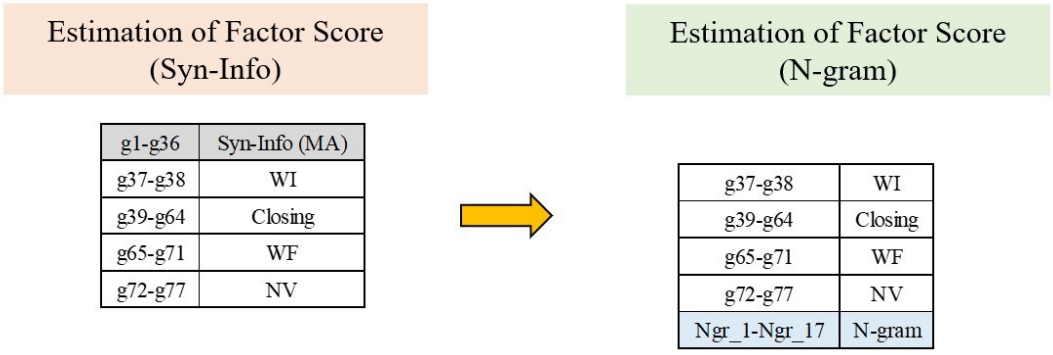

Figure 2: Differences of Feature Values Used between N-gram and MA

4.4 Estimation Result

MCCs obtained as a result of multiple regression analysis regarding N-gram are shown in Table 4. Similar to the previous analysis using mere MA depicted in Section 3.2, all the MCCs were over 0.9 for any cases of 2-gram through 5-gram. It has also been shown that employing N-gram would be as applicable as the case utilizing MA.

Table 4: MCCs: 2-gram, 3-gram, 4-gram and 5-gram [12-14]

Factor		MCC			
		2-gram	3-gram	4-gram	5-gram
1st	(Accuracy)	0.989	0.993	0.993	0.998
2nd	(Displeasure)	0.999	0.987	0.987	0.991
3rd	(Creativity)	0.981	0.998	0.998	0.976
4th	(Ease)	0.990	0.995	0.995	0.994
5th	(Persistence)	0.993	0.976	0.976	0.999
6th	(Ambiguity)	0.998	0.994	0.994	0.986
7th	(Moving)	0.999	0.996	0.996	0.992
8th	(Effort)	0.995	0.968	0.968	1.000
9th	(Hotness)	0.995	0.998	0.998	0.954

5 Multiple Regression Analysis Using 6-gram

5.1 Aim

In applying N-gram to this methodology, so far 2-gram, 3-gram, 4-gram and 5-gram have been analyzed as the replacement of Syn-Info. In order to verify the usage of N-gram, a longer unit of N-gram, 6-gram, would be applied and analyzed as well. Thus, the objective of this paper is to append 6-gram as the former analyses where previous N-grams and MA were employed. Similar to those prior analyses, multiple regression analysis is performed utilizing the feature values of 6-gram. The analysis result using 6-gram is then compared with those employing previous N-grams or MA to see the validity of using 6-gram. The 68 feature values including 6-gram are jointly used as EVs, while the factor scores of the nine factors are set as respondent variables.

5.2 Analysis Method of 6-gram

Similar to the prior analyses utilizing previous N-grams or MA as stated in Sections 3.2 and 4, multiple regression analysis is executed to obtain factor scores of Q&A statements. The feature values set as respondent variables and explanatory variables are described in Section 5.1. The outline of extracting the feature values for 6-gram through total amounts for the 60 Q&A statements is described in Table 5. As for the feature values of 6-gram, with a view to direct comparison, the analyses among 6-gram and previous N-grams, the amount of 6-gram extracted is the same as those of previous N-grams: seventeen. For the 60 experimental materials, 2552 combinations of 6-gram were generated. The respective appearance numbers of each 6-gram combination were then counted and summed up for the respective 60 statements, as shown in Table 5-(a). The row entitled “Sum_6-gram” indicates the total of appearance number of 60 statements for the respective 6-gram combinations. These 6-gram combinations are then sorted in the descending order of their total appearance times, as shown in Table 5-(b). The contents of these feature values are denoted as 6gr_1, 6gr_2, … , 6gr_17, as shown in Table 6.

Table 5: Outline of sorting and extracting 6-gram for 60 Q&A statements

(a) Before sort

2552 combinations

60 Q&A

Q&A	…	[Noun-Part-Noun-Part-Noun-Part]	…	[Noun-Part-Verb-Part-Verb-Aux]	…	[Sign-Noun-Part-Noun-Part-Noun]	…
QA01	…	2	…	0	…	1	…
AA01-01	…	6	…	0	…	3	…
AA01-02	…	0	…	0	…	0	…
AA01-03	…	0	…	0	…	0	…
AA01-04	…	0	…	0	…	0	…
QA02	…	0	…	0	…	0	…
…	…	…	…	…	…	…	…
AA12-03	…	0	…	0	…	0	…
AA12-04	…	0	…	3	…	0	…
Sum_6-gram	…	27	…	29	…	17	…

(b) After sort

17 feature values

60 Q&A

Q&A	6gr1 [Noun-Noun-Noun-Noun-Noun-Noun]	6gr2 [Noun-Part-Verb-Part-Verb-Aux]	6gr3 [Noun-Part-Noun-Part-Noun-Part]	6gr4 [Noun-Part-Noun-Part-Verb-Part]	… … …	6gr17 [Verb-Aux-Aux-Sign-Noun-Part]
QA01	0	0	2	0	…	0
AA01-01	0	0	6	0	…	1
AA01-02	0	0	0	0	…	0
AA01-03	0	0	0	1	…	1
AA01-04	0	0	0	0	…	0
QA02	0	0	0	2	…	0
…	…	…	…	…	…	…
AA12-03	0	0	0	0	…	0
AA12-04	0	3	0	2	…	2
Sum_6-gram	99	29	27	26	…	13

Table 6: Feature Values of 6-gram

g	Feature Values: Syn-Info (6-gram)
6gr_1	[Noun - Noun - Noun - Noun - Noun - Noun]
6gr_2	[Noun - Aux - Verb - Aux - Verb - Aux]
6gr_3	[Noun - Aux - Noun - Aux - Noun - Aux]
6gr_4	[noun - Aux - Noun - Aux - Verb - Aux]
6gr_5	[Aux - Noun - Aux - Verb - Aux - Verb]
6gr_6	[Sign - Noun - Aux - Noun - Aux - Noun]
6gr_7	[Aux - Verb - Aux - Sign - Noun - Aux]
6gr_8	[Aux - Aux - Sign - Noun - Aux - Verb]
6gr_9	[Sign - Noun - Aux - Noun - Aux - Verb]
6gr_10	[Verb - Aux - Sign - Noun - Aux - Noun]
6gr_11	[Aux - Sign - Noun - Aux - Noun - Aux]
6gr_12	[Noun - Aux - Noun - Aux - Verb - Aux]
6gr_13	[Aux - Noun - Aux - Noun - Aux - Verb]
6gr_14	[Aux - Noun - Aux - Noun - Aux - Noun]
6gr_15	[Noun - Aux - Verb - Aux - Verb - Noun]
6gr_16	[Noun - Aux - Aux - Sign - Noun - Aux]
6gr_17	[Verb - Aux - Aux - Sign - Noun - Aux]

Similar to the former analyses explained in Section 4.3 and Figure 2, the feature values of Syn-Info (g1-g36) extracted through MA are substituted for those based on 6-gram (6gr_1, 6gr_2, …, 6gr_17). The 68 feature values, 6-gram along with WI (g37-g38), Closings (g39-g64), WF (g65-g71), and NV (g72-g77), are set as EVs. The abbreviations of PoSs that composes 6-gram are explained in Section 4.2.

5.3 Estimation Result

MCCs obtained through multiple regression analysis are shown in Table 7. Similar to the cases utilizing previous N-grams or MA described in Sections 3.2 and 4.4, all the MCCs are above 0.9 for all the nine factors for the cases using 6-gram. Thus, similar to the cases of previous N-grams, employing 5-gram instead of Syn-Info could be more productive in estimating factor scores than utilizing MA alone.

Table 7: Multiple Correlation Coefficient (MCC): 6-gram

Factor		MCC (6-gram)
1st	(Accuracy)	0.999
2nd	(Displeasure)	0.998
3rd	(Creativity)	0.996
4th	(Ease)	1.000
5th	(Persistence)	0.983
6th	(Ambiguity)	0.999
7th	(Moving)	0.997
8th	(Effort)	0.988
9th	(Hotness)	0.980

In similar fashion as the previous N-grams, EVs with absolute values of the standardized partial regression coefficient (SPRCs) over 1.0 are narrowed down in order to see whether 6-gram would play a vital role in improving estimation accuracy can be verified. The maximum three largest positive/negative feature values are shown in Table 8. When there are over three EVs that meet the condition of positive/negative SPRC more than 1.0 for each factor, the maximum three positive/negative largest EVs are narrowed down and shown in Table 8. Nevertheless, although the amount of EVs whose absolute values of positive/negative SPRC is over 1.0 is only one or two, such EVs are shown as they are, e.g., positive/negative SPRC for 2nd factor, negative SPRC for 5th factor, and positive SPRC for 6th factor. The column entitled "FV" shows the classifications of feature values that coincides with the column entitled "EV" as shown in Table 6 and Appendix A. "FV" conveys "WI," "Closing," "WF," "NV," or "6-gram." From the list shown in Table 8, feature values of 6-gram are extracted among the three positive/negative SPRCs in six factors (1st, 2nd, 4th, 5th, 7th, and 8th) out of nine.

Table 8: Explanatory Variable (EV) and Feature Value (FV) with Higher Absolute Values of Standardized Partial Regression Coefficient (SPRC): 6-gram

1st (Accuracy)		
EV	FV	SPRC
g72	NV	1.45
g76	NV	1.40
g68	WF	1.31
6gr_g13	6-gram	-1.45
g64	Closing	-1.57
g65	WF	-1.83

2nd (Displeasure)		
EV	FV	SPRC
6gr_g13	6-gram	1.24
g45	Closing	-1.02

3rd (Creativity)		
EV	FV	SPRC
g65	WF	6.76
g73	NV	2.96
g44	Closing	2.53
g59	Closing	-2.64
g72	NV	-4.51
g76	NV	-5.43

4th (Ease)		
EV	FV	SPRC
6gr_7	6-gram	1.32
g68	WF	1.27
g59	Closing	1.00
6gr_3	6-gram	-1.42
g65	WF	-1.55
6gr_2	6-gram	-1.70

5th (Persistence)		
EV	FV	SPRC
g75	NV	1.77
g64	Closing	1.72
6gr_14	6-gram	1.16
6gr_3	6-gram	-1.74

6th (Ambiguity)		
EV	FV	SPRC
g76	NV	2.86
g72	NV	1.75
g73	NV	-1.14
g44	Closing	-1.75
g65	WF	-1.83

7th (Moving)		
EV	FV	SPRC
6gr_9	6-gram	1.90
g64	Closing	1.45
g70	WF	1.41
g37	WI	-1.08
6gr_3	6-gram	-1.53
g76	NV	-1.55

8th (Effort)		
EV	FV	SPRC
g64	Closing	2.75
6gr_9	6-gram	2.13
g49	Closing	1.83
6gr_4	6-gram	-1.87
6gr_3	6-gram	-2.13
g76	NV	-2.60

9th (Hotness)		
EV	FV	SPRC
g65	WF	3.53
g73	NV	2.11
g44	Closing	2.07
g59	Closing	-1.48
g72	NV	-1.77
g76	NV	-2.49

MCCs obtained as a result of multiple regression analysis are summarized in Table 9. Similar to the former analyses using MA depicted in Sections III-B and IV-D, all the MCCs are over 0.9 for all the nine factors for the cases of 5-gram. Therefore, similar to the previous N-grams, applying 6-gram instead of Syn-Info could be more productive in estimating factor scores than utilizing MA alone. As a whole, it could also be concluded that N-gram could play a similar role in estimating factor scores of Q&A statements as MA alone.

6 Considerations

One of the objectives of applying N-gram in place of MA is to obtain more concise multiple regression equations. From the viewpoint of computational cost, when a quadratic term was required for better estimation accuracy, this may have resulted in complex equation models. For the case of employing N-gram, on the other hand, a monadic term alone was sufficient for higher MCC, where regarding quadratic term was not essential. Therefore, lower computational cost could be realized due to fewer explanation variables with the application of N-gram.

In Section 5.3, with a view to verifying if N-gram would be effective in estimation factor scores, EVs whose absolute values of the SPRCs are larger than 1.0 are focused on, as shown in Table 8. In order to summarize the results throughout N-grams analyzed, the summarization of SPRC is shown in Table 9. The detailed results from 2-grams to 5-grams [12-14] are shown in Appendix C. As explained in Section 5.3, for respective N-gram, the maximum three feature values whose absolute values of positive/negative SPRC are over 1.0 have been inspected. For respective N-gram, if feature values of N-gram are included in SPRC among the maximum three positive/negative feature values, circle is assigned; otherwise, cross is given. In the column entitled "SPRC," the number of circle out of positive/negative among nine factors is shown. In the column entitled "Factor," for respective factor, one is counted if a circle is given in either of positive or negative. In other words, zero is counted if crosses are given on both positive and negative. Taking an example of 6-gram, since eleven circles are allocated, 11 is given in the column entitled "SPRC." On the other hand, at least one circle is given on six factors (namely, crosses are given in 3th, 6th and 9th factor), 6 is allocated in the column entitled "Factor." From the summarization shown in Table 9, 2-gram shows best in terms of "SPRC" and "Factor." As a whole, any of five cases would be applicable to estimating factor scores.

Table 9: Comparison of Multiple Correlation Coefficients (MCCs): MA, N-gram

N-gram		Factor									Total	
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	SPRC	Factor
2-gram	Positive	○	○	○	○	○	○	○	○	○	17	9
	Negative	×	○	○	○	○	○	○	○	○		
3-gram	Positive	×	×	○	×	×	○	○	○	×	8	6
	Negative	○	×	×	×	×	×	○	○	○		
4-gram	Positive	○	○	○	○	○	○	×	○	○	15	8
	Negative	○	×	○	○	○	○	×	○	○		
5-gram	Positive	×	×	○	○	×	×	○	○	×	6	5
	Negative	○	×	×	○	×	×	×	×	×		
6-gram	Positive	×	○	×	○	○	×	○	○	×	11	6
	Negative	○	○	×	○	○	×	○	○	×		

For the purpose of direct comparison of MCCs among 6-gram and previous N-grams, these figures are summarized in Table 10. From these results, employing 2-gram, 3-gram or 6-gram could be the best among the five cases. Meanwhile, eight factors except the 1st factor show better result for the case using N-gram than that which employs MA. Hence, as a whole, the application of N-gram would play a significant role in improving MCCs. Therefore, it could be implied that applying N-gram should outperform the result using mere MA.

Table 10: Comparison of Multiple Correlation Coefficients (MCCs): MA, N-gram

Factor	MA	N-gram				
		2-gram	3-gram	4-gram	5-gram	6-gram
1st (Accuracy)	1.00	0.989	0.993	0.999	0.996	0.999
2nd (Displeasure)	0.947	0.999	0.987	0.985	0.982	0.998
3rd (Creativity)	0.877	0.981	0.998	0.971	0.952	0.996
4th (Ease)	0.908	0.990	0.995	0.993	0.988	1.00
5th (Persistence)	0.966	0.993	0.976	0.994	0.999	0.983
6th (Ambiguity)	0.899	0.998	0.994	0.983	0.973	0.999
7th (Moving)	0.997	0.999	0.996	0.945	0.984	0.997
8th (Effort)	0.904	0.995	0.968	0.988	1.00	0.988
9th (Hotness)	0.954	0.995	0.998	0.973	0.911	0.980

From the viewpoints of MCCs, any of these six cases would be applicable. However, it could be suggested that the best method ought to be applied to each factor according to their respective best estimation result. Specifically, for example, 2-gram could be applied to the 2nd factor (Displeasure) and 7th (Moving). Similarly, 3-gram would convert the best result for the 3rd factor (Creativity) and 9th (Hotness). Likewise, 5-gram would be most suitable for the 5th factor (Persistence) and the 8th (Effort), while the 4th factor (Ease) and 6th (Ambiguity) would be most productive with the application of 6-gram. On the other hand, the 1st factor (Accuracy) would be best when MA is applied.

It would be necessary to take a look at the amounts of combinations and those of top 17 feature values for the respective N-gram shown in Table 11. The notation "Ngr_k," where k ranges from 1 to 17, indicates the sum of N-gram for 60 experimental materials, as explained in Sections 4.3 and 5.2 and depicted in Figures 2 and 3. As shown in Table 10, the bigger N becomes, the more combinations are generated. Inversely, the larger N is, the smaller Ngr_k gets. For 6-gram, the amounts of Ngr_k are 13 when k is 15 (6gr_15), 16 (6gr_16) and 17 (6gr_17). If 7-gram would be applied, while the number of combinations would increase, it would be unable to extract even 17 feature values. Hence, the methodology of applying N-gram might show limitations at 6-gram (N=6). These experimental materials were chosen by weaving long/short sentences, while being attentive not to include just too long sentences nor only too short ones. If the experimental materials included sentences that were as long as possible, further N-gram beyond 6-gram could be applicable.

7 Conclusion

In this paper, for the purpose of reinforcing the validity of applying N-gram to obtain factor scores of Q&A statements, 6-gram was applied to the feature values of statements. Through performing multiple regression analysis, the feature values on the basis of 6-gram, and those other than syntactic information were collectively utilized as explanatory variables, while the factor scores for nine factors were set as respondent variables. As a result of the further analysis,

Table 11: Amounts of Combinations and Top 17 Feature Values for Respective N-gram

N-gram	Combination	Ngr_k (1≦k≦17)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2-gram	27	709	440	383	336	292	238	234	218	183	153	142	141	107	98	86	85	77
3-gram	85	162	154	113	85	82	82	64	58	41	37	35	33	29	24	21	20	20
4-gram	840	146	116	107	80	79	79	71	69	59	56	55	52	52	50	50	50	50
5-gram	1033	58	57	53	45	40	34	33	32	32	30	25	25	25	24	24	22	22
6-gram	2552	99	29	27	26	24	17	17	16	16	16	16	16	15	14	13	13	13

6-gram also outperformed MA in terms of estimation accuracy. As a whole, it could be implied that the application of N-gram would be more effective than MA to estimate factor scores. At the same time, it could be also implied that 6-gram would be the limitations for the methodology of applying N-gram to the feature values.

For future work, the contents and meanings of Q&A statements must be taken into consideration. In addition, cross-validation test ought to be performed to avoid the possibility of overfitting. Furthermore, using the feature values of Syn-Info extracted through MA, the factor scores obtained then were subsequently utilized for investigating the possibility to find respondents who would be most likely to appropriately answer a newly posted question [11]. Therefore, whether the feature values based on N-gram could be effective in detecting appropriate respondents must be examined and compared with the case of MA. As an initial step of this method, studies based on 2-gram are planned to be applied. As most of the feature values utilized in this work have been mainly dependent on Japanese language materials, the generalization of these studies to other languages must also be included as another topic in future work. Whether this methodology could be extended to other datasets or fields would also have to be addressed in other future works. As an example of another dataset, the method have been applied to reviews of EC sites [20, 21].

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Appendix

A Detailed Explanation of 77 Feature Values of Statements

The 77 feature values adopted in the previous work explained in Section 3.2 are shown in Table 12 and summarized as follows, with their notation denoted as g1, g2, …, g77 [11].

- Syntactic information (Syn-Info, g1-g36): Syn-info is the feature value of statements extracted through MA, including statistics of statements, e.g., number/length of statements, and number/percentage of Part-of-Speeches (e.g., nouns, verbs etc.), etc.
- Word imageability (WI, g37-g38): WI is a subjective attribute implying how diverse imaginations can be recalled from words. The characteristic value of WI ranges from 1 to 7.
- Closings are the fundamental Japanese words adopted were "zo," "da," "yo," "ne," "ka," "na," "shi," "desu," "masu," "tai," and "nai" [6]. Closing also includes the words "desuka," "naidesu," "masuka," and "mashita"; mixtures of "desu," "ka," "nai," "desu," and "masu."
- Word familiarity (WF, g65-g71): WF is an index indicating how people feel or think either aurally or visually with a word [11]. Here, words are evaluated either aurally or visually using scores ranging from 1 to 7. Though both types of data are recorded, only data evaluated visually are to be adopted.

Table 12: Feature Values of Statements Used for MA

(a) Syntactic information (Syn-Info)

g	Feature Values (Syn-Info)
g1	Auxiliary verbs (vocabulary)
g2	Prefixes
g3	Signs (vocabulary)
g4	Sentences
g5	Average length of sentences (letters)
g6	Katakanas (word)
g7	Full-size characters (word)
g8	Full-size alphanumeric characters (word)
g9	Adjectives (word)
g10	Adverbs (word)
g11	Pre-noun adjectivals (word)
g12	Conjunctions (word)
g13	Interjections (word)
g14	Hiraganas (%)
g15	Chinese characters (%)
g16	Katakanas (%)
g17	Signs (%)
g18	Type Token Ratio (TTR)
g19	Full-size characters (%)
g20	Alphanumeric characters (%)
g21	Full-size alphanumeric characters (%)
g22	Nouns (%)
g23	Adjectives (%)
g24	Adverbs (%)
g25	Pre-noun adjectivals (%)
g26	Conjunctions (%)
g27	Interjections (%)
g28	Exclamation marks
g29	Question marks
g30	Periods
g31	Commas
g32	Middle dots
g33	Three dot leaders
g34	Quotation marks
g35	Parentheses
g36	Slash characters

(b) Word imageability (WI)

g	Feature Values: Cl-word
g37	WI over 4.0 below 5.0 （word）
g38	WI over 6.5 below 7.0 （word）

(c) Closing sentence expressions (Closing)

g	Feature Values: Closing
g39	"ka" (word)
g40	"na" (word)
g41	"shi" (word)
g42	"tai" (word)
g43	"nai" (word)
g44	"da" (cl-word)
g45	"ka" (cl-word)
g46	"na" (cl-word)
g47	"shi" (cl-word)
g48	"desu" (cl-word)
g49	"masu" (cl-word)
g50	"tai" (cl-word)
g51	"nai" (cl-word)
g52	"zo" (%)
g53	"da" (%)
g54	"yo" (%)
g55	"ne" (%)
g56	"ka" (%)
g57	"desu" (%)
g58	"masu" (%)
g59	"nai" (%)
g60	"ka" (closing (%))
g61	"desuka" (word)
g62	"naidesu" (word)
g63	"masuka" (word)
g64	"mashita" (word)

(d) Word familiarity (WF)

g	Feature Values: WF
g65	WF percentage of words
g66	WF over 6.5 below 7.0 (vocabulary)
g67	WF over 4.0 below 5.0 （word）
g68	WF over 5.0 below 6.0 （word）
g69	WF over 5.5 below 6.0 （word）
g70	WF over 6.0 below 7.0 （word）
g71	WF over 6.0 below 6.5 （word）

(e) Notation validity (NV)

g	Feature Values: NV
g72	NV percentage of words
g73	NV over 3.0 below 4.0 （word）
g74	NV over 3.5 below 4.0 （word）
g75	NV over 4.0 below 5.0 （word）
g76	NV over 4.0 below 4.5 （word）
g77	NV over 5.0 below 6.0 （word）

- Notation validity (NV, g72-g77): NV means the validity of a word and is evaluated by an index ranging from 1 to 5 [11]. A word can possess multiple different styles or meanings. Taking an example of the Japanese word "kosho," it could mean "breakdown," "lake," "name," etc., and written in the either style of Chinese characters, hiragana or katakana characters, or their mixtures thereof.

B Feature Values of Previous N-grams

The 17 feature values adopted in previous N-grams, where N is 2, 3, 4 and 5, are shown in Table 13. These feature values denoted as "Ngr_1, Ngr_2, …, Ngr_17" for N-gram [12-14].

Table 13: Amounts of Combinations and Top 17 Feature Values for Respective N-gram

(a) 2-gram [12]

g	Feature Values: (2-gram)
2gr_1	[Noun - Part]
2gr_2	[Part - Verb]
2gr_3	[Part - Noun]
2gr_4	[Noun - Noun]
2gr_5	[Sign - Noun]
2gr_6	[Verb - Aux]
2gr_7	[Part - Sign]
2gr_8	[Sign - Part]
2gr_9	[Aux - Part]
2gr_10	[Noun - Aux]
2gr_11	[Aux - Sign]
2gr_12	[Verb - Noun]
2gr_13	[Noun - Verb]
2gr_14	[Aux - Noun]
2gr_15	[Aux - Aux]
2gr_16	[Sign - Sign]
2gr_17	[Part - Part]

(b) 3-gram [12]

g	Feature Values: (3-gram)
3gr_1	[Sign - Noun - Part]
3gr_2	[Noun - Noun - Noun]
3gr_3	[Part - Sign - Noun]
3gr_4	[Part - Verb - Noun]
3gr_5	[Sign - Noun - Noun]
3gr_6	[Verb - Noun - Part]
3gr_7	[Noun - Aux - Part]
3gr_8	[Verb - Aux - Noun]
3gr_9	[Noun - Part - Adj]
3gr_10	[Aux - Aux - Sign]
3gr_11	[Sign - Sign - Sign]
3gr_12	[Part - Sign - Adv]
3gr_13	[Noun - Verb - Aux]
3gr_14	[Aux - Noun - Aux]
3gr_15	[Sign - Noun - Sign]
3gr_16	[Noun - Verb - Noun]
3gr_17	[Noun - Noun - Aux]

(c) 4-gram [13]

g	Feature Values: 4-gram
4gr_1	[Noun - Part - Noun - Part]
4gr_2	[Noun - Noun - Noun - Noun]
4gr_3	[Noun - Part - Verb - Part]
4gr_4	[Sign - Noun - Part - Noun]
4gr_5	[Part - Noun - Part - Verb]
4gr_6	[Noun - Part - Verb - Aux]
4gr_7	[Part - Verb - Part - Verb]
4gr_8	[Part - Noun - Part - Noun]
4gr_9	[Sign - Noun - Part - Verb]
4gr_10	[Aux - Sign - Noun - Part]
4gr_11	[Part - Sign - Noun - Part]
4gr_12	[Noun - Part - Verb - Noun]
4gr_13	[Noun - Noun - Part - Noun]
4gr_14	[Part - Verb - Noun - Part]
4gr_15	[Noun - Part - Noun - Noun]
4gr_16	[Noun - Part - Noun - Verb]
4gr_17	[Verb - Part - Verb - Aux]

(d) 5-gram [14]

g	Feature Values: 5-gram
5gr_1	[Noun - Part - Noun - Part - Verb]
5gr_2	[Noun - Part - Verb - Part - Verb]
5gr_3	[Noun - Part - Noun - Part - Noun]
5gr_4	[Sign - Noun - Part - Noun - Part]
5gr_5	[Part - Noun - Part - Verb - Part]
5gr_6	[Part - Noun - Part - Noun - Part]
5gr_7	[Aux - Sign - Noun - Part - Noun]
5gr_8	[Noun - Part - Verb - Noun - Part]
5gr_9	[Part - Verb - Part - Verb - Aux]
5gr_10	[Aux - Part - Sign - Noun - Part]
5gr_11	[Noun - Noun - Part - Noun - Part]
5gr_12	[Part - Sign - Noun - Part - Verb]
5gr_13	[Verb - Aux - Sign - Noun - Part]
5gr_14	[Noun - Part - Verb - Aux - Part]
5gr_15	[Noun - Part - Noun - Noun - Part]
5gr_16	[Part - Sign - Noun - Noun - Part]
5gr_17	[Part - Sign - Noun - Part - Noun]

C SPRCs for Previous N-grams

Feature values with absolute values of SPRCs over 1.0 are shown in Table 14 [12-14].

Table 14: Feature values with absolute values of SPRC over 1.0 (Previous N-grams)

(a) 2-gram [12]

1st (Accuracy)		
EV	FV	SPRC
2gr_7	2-gram	1.27
2gr_10	2-gram	1.24

2nd (Displeasure)		
EV	FV	SPRC
2gr_2	2-gram	5.65
g70	WF	3.28
2gr_9	2-gram	2.05
g39	Closing	-2.60
2gr_10	2-gram	-2.86
2gr_6	2-gram	-3.09

3rd (Creativity)		
EV	FV	SPRC
g65	WF	3.68
g39	Closing	3.01
2gr_8	2-gram	2.83
g72	NV	-2.18
g70	WF	-3.49
2gr_2	2-gram	-6.90

4th (Ease)		
EV	FV	SPRC
2gr_3	2-gram	3.71
2gr_2	2-gram	2.82
2gr_13	2-gram	-1.17
2gr_1	2-gram	-5.30

5th (Persistence)		
EV	FV	SPRC
2gr_3	2-gram	3.00
2gr_6	2-gram	1.59
g45	Closing	1.35
2gr_9	2-gram	-1.23
2gr_1	2-gram	-2.40

6th (Ambiguity)		
EV	FV	SPRC
2gr_1	2-gram	1.66
2gr_9	2-gram	1.29
2gr_2	2-gram	-1.89
2gr_3	2-gram	-2.32

7th (Moving)		
EV	FV	SPRC
2gr_1	2-gram	4.12
2gr_10	2-gram	2.93
2gr_8	2-gram	2.19
2gr_3	2-gram	-2.43
2gr_9	2-gram	-3.17
2gr_2	2-gram	-5.20

8th (Effort)		
EV	FV	SPRC
2gr_6	2-gram	2.85
g45	Closing	2.25
2gr_1	2-gram	2.20
g65	WF	-1.41
2gr_2	2-gram	-1.61
g37	WI	-1.71

9th (Hotness)		
EV	FV	SPRC
2gr_10	2-gram	5.21
2gr_6	2-gram	4.54
2gr_8	2-gram	3.54
2gr_13	2-gram	-2.98
g70	WF	-5.90
2gr_2	2-gram	-12.08

(b) 3-gram [12]

1st (Accuracy)		
EV	FV	SPRC
g70	WF	1.90
g37	WI	1.47
g43	Closing	1.14
g62	Closing	-1.06
3gr_6	3-gram	-1.54
g64	Closing	-1.65

2nd (Displeasure)		
EV	FV	SPRC
g76	NV	1.16
g73	NV	-0.77

3rd (Creativity)		
EV	FV	SPRC
g64	Closing	2.83
3gr_6	3-gram	2.03
g65	WF	1.95
g76	NV	-1.68
g37	WI	-2.09
g70	WF	-2.36

4th (Ease)		
EV	FV	SPRC
g65	WF	1.42
g44	Closing	1.29
g70	WF	-1.10
g76	NV	-1.34
g72	NV	-1.72

5th (Persistence)		
EV	FV	SPRC
g45	Closing	0.97
g60	Closing	-0.47

6th (Ambiguity)		
EV	FV	SPRC
g66	WF	1.04
3gr_4	3-gram	-1.22
g43	Closing	-1.31
g70	WF	-1.34

7th (Moving)		
EV	FV	SPRC
3gr_6	3-gram	1.56
3gr_4	3-gram	-1.30

8th (Effort)		
EV	FV	SPRC
3gr_6	3-gram	2.08
g68	WF	1.61
g59	Closing	1.59
3gr_13	3-gram	-1.37
g43	Closing	-1.58
g37	WI	-1.61

9th (Hotness)		
EV	FV	SPRC
g66	WF	2.04
g65	WF	1.87
g73	NV	1.77
g76	NV	-2.04
3gr_4	3-gram	-2.11
g70	WF	-3.26

(c) 4-gram [13]

1st (Accuracy)		
EV	FV	SPRC
g37	WI	3.76
g68	WF	3.15
4gr_g8	4-gram	2.15
4gr_g7	4-gram	-1.91
4gr_g16	4-gram	-2.01
g76	NV	-3.12

2nd (Displeasure)		
EV	FV	SPRC
4gr_g6	4-gram	1.45
g56	Closing	1.33
4gr_g7	4-gram	1.32
g39	Closing	-1.04

3rd (Creativity)		
EV	FV	SPRC
g76	NV	4.07
4gr_g9	4-gram	2.58
4gr_g16	4-gram	2.35
4gr_g8	4-gram	-2.88
g68	WF	-4.00
g37	WI	-4.51

4th (Ease)		
EV	FV	SPRC
4gr_g9	4-gram	1.56
g76	NV	1.22
4gr_g5	4-gram	1.19
g62	Closing	-1.04
4gr_g1	4-gram	-1.08
4gr_g6	4-gram	-1.39

5th (Persistence)		
EV	FV	SPRC
4gr_g8	4-gram	1.73
4gr_g5	4-gram	1.50
g43	Closing	-1.17
4gr_g1	4-gram	-1.80

6th (Ambiguity)		
EV	FV	SPRC
g62	Closing	0.52
4gr_g6	4-gram	0.50
4gr_g14	4-gram	0.49
g44	Closing	-0.62
4gr_g9	4-gram	-0.64
g73	NV	-0.66

7th (Moving)		
EV	FV	SPRC
g76	NV	4.33
g48	Closing	2.32
g72	NV	1.92
g37	WI	-2.36
g44	Closing	-2.40
g73	NV	-2.43

8th (Effort)		
EV	FV	SPRC
g76	NV	4.07
g48	Closing	2.43
4gr_g16	4-gram	2.28
4gr_g8	4-gram	-2.76
g68	WF	-2.80
g37	WI	-4.55

9th (Hotness)		
EV	FV	SPRC
g65	WF	2.25
4gr_g1	4-gram	2.02
g44	Closing	1.25
4gr_g9	4-gram	-1.39
4gr_g4	4-gram	-1.44
g76	NV	-2.05

(d) 5-gram [14]

1st (Accuracy)		
EV	FV	SPRC
g37	WI	1.08
5gr_g6	5-gram	-1.10

2nd (Displeasure)		
EV	FV	SPRC
g56	Closing	1.74
g49	Closing	1.04
g60	Closing	-1.10
g39	Closing	-1.86

3rd (Creativity)		
EV	FV	SPRC
g65	WF	3.89
g73	NV	2.12
5gr_g17	5-gram	1.67
g59	Closing	-1.62
g76	NV	-2.15
g72	NV	-2.56

4th (Ease)		
EV	FV	SPRC
g48	Closing	2.69
g76	NV	2.61
5gr_g5	5-gram	2.05
g68	WF	-1.99
5gr_g9	5-gram	-2.24
g37	WI	-3.62

5th (Persistence)		
EV	FV	SPRC
g75	NV	2.69
g76	NV	1.40
g61	Closing	1.29
g70	WF	-1.80
g73	NV	-2.12
g68	WF	-2.20

6th (Ambiguity)		
EV	FV	SPRC
g37	WI	1.76
g73	NV	1.25
g68	WF	1.22
g76	NV	-1.09
g75	NV	-1.44
g48	Closing	-1.61

7th (Moving)		
EV	FV	SPRC
g76	NV	2.63
g48	Closing	2.13
5gr_g12	5-gram	1.74
g37	WI	-2.06
g73	NV	-2.32
g44	Closing	-2.36

8th (Effort)		
EV	FV	SPRC
g72	NV	2.09
g48	Closing	1.81
5gr_g6	5-gram	1.47
g74	NV	-1.39
g37	WI	-2.05
g65	WF	-2.49

9th (Hotness)		
EV	FV	SPRC
g68	WF	3.02
g73	NV	2.94
g70	WF	2.39
g61	Closing	-1.64
g75	NV	-2.38
g76	NV	-2.48