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# Reflective visualization of dispute resolution

Yoshiharu Maeno
Social Design Group
Bunkyo-ku, Tokyo 112-0011, Japan.
maeno.yoshiharu@socialdesigngroup.com

Katsumi Nitta
Tokyo Institute of Technology
Yokohama-shi, Kanagawa 226-8502, Japan.
nitta@ntt.dis.titech.ac.jp

Yukio Ohsawa
Tokyo University
Bunkyo-ku, Tokyo 113-8563, Japan.
ohsawa@sys.t.u-tokyo.ac.jp

***Abstract*—Mediation is a form of alternative dispute resolution which aims at assisting disputants in reaching an agreement on a disputed matter. Debate ensues on what skills an individual needs to play a mediator's role effectively. Education and training for mediators become complex issues. Then how can mediator's skills be trained in spite that the skills can not be defined clearly? In cognitive science visualization of and reflection on one's behavior is proven effective in such a situation. In this paper we explore a text processing method for reflective visualization of a dialogue. The dialogue is a time sequence of utterances from a mediator and disputants. The method visualizes an inter-topic association which foreshadows the intentional or unintentional subsequent development of topics indicated by temporal topics clusters far apart in time. The method is applied to a mediation case where a dispute between a seller and a buyer on cancelling an purchase transaction at an online auction site is resolved.**

***Index Terms*—Dispute resolution, Mediation, Reflection, Visualization**

## I. Introduction

Resolving a conflict between parties having opposing opinions is an important social requirement. Mediation is a form of alternative dispute resolution, which refers to a rather private and confidential extrajudicial process. Mediation aims at assisting disputants in reaching an agreement on a disputed matter. Companies often hire mediators in an attempt to resolve a dispute with workers' unions. Mediation is different from arbitration where an arbitrator imposes a solution on the disputants. Rather, a mediator uses appropriate skills to improve the dialogue between the disputants and find solution.

Mediator's skills range widely from the ability to remain neutral, the ability to move the disputants from the impasse points, to the ability to evaluate the strength and weakness of the disputants correctly. Therefore, education and training for mediators become a complex issue. Debate ensues on what personal attributes an individual needs to play a mediator's role effectively. The necessary skills and personal attributes have not been identified clearly yet. However, appropriate means is necessary to education and training for mediators, as resolving a dispute by mediation experiences increasing acceptance and utilization.

The idea of reflection is a clue when we need to improve a skill which can not be defined clearly and taught by trainers. Reflection in cognitive science [12] and computer-mediated communication [15] means the ability to recognize and understand oneself, discover something unexpected, and create something new [6], [13], [14]. Particularly, visualization of the past utterances, decision-makings, and actions is one of the most practical tools to foster reflection. For example, presenting the design work until obtaining the intermediate outcome of an art piece in the form of a graphical diagram is proven effective in improving the quality of the final output in a university education program of creativity [5]. Reflective visualization and verbalization are proven effective in helping a person become aware of his or her unconscious preferences [10]. We expect that such reflective visualization is also promising in education and training for mediation trainees. Utterances are relevant and convenient information records for the trainees to reflect on. They are essential inputs to negotiation log analysis [11] and online agent based negotiation assistant system [16], [17]. Similarly, mediators and disputants can reflect on themselves by looking back the way how the dispute was resolved in a dialogue.

In this paper, we explore a text processing method of the dialogue for reflective visualization and apply it to a mediation case. This paper is organized as follows. The text processing method is proposed in II. After defining a dialogue as a time sequence of utterances from a mediator and disputants, it describes the method to derive temporal topic clusters and inter-topic association from the recorded utterance texts, and draw a graph-structured diagram which makes the clusters and associations visible clearly. The inter-topic association foreshadows the intentional or unintentional subsequent development of topics indicated by temporal topics clusters far apart in time. Demonstration of the method using a mediation case is presented in III. The method visualizes the way how mediation trainees resolved a dispute between a seller and a buyer on cancelling an purchase transaction at an online auction site. The resulting implications and future works are discussed in IV.

## II. Method

### A. Dialogue

The dialogue $\boldsymbol{d}$ is a time sequence of the recorded utterance texts $u_t$ from a mediator and disputants. It is represented by eq.(1) formally. The subscript $t$ means the time when the utterance is observed. We do not use the absolute time from the beginning of mediation. Instead, the $i$-th utterance from the beginning is associated with an integer time $t = i$ approximately. In eq.(1), $T$ is the number of utterances in mediation.

$$\boldsymbol{d} = (u_0, \ldots, u_t, \ldots, u_{T-1}). \quad (1)$$



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A recorded utterance text is a set of words $w_i$ which appear in the sentences in an utterance. It is in the form of eq.(2). The number of words in an utterance text $u_t$ is $|u_t|$.

$$u_t = \{w_i\} \ (0 \leq i < |u_t|). \tag{2}$$

The utterances are analyzed morphologically while assembling a dialogue. Morphology is the identification, analysis and description of structure of words. Verbs are changed into unconjugated forms. Nouns are changed into un-inflected forms. Besides, irrelevant words are deleted. Major irrelevant words are articles, prepositions, pronouns, and conjunctions. Periods are not words. For example, the first utterance of a mediator, *Thank you for agreeing in attempting to solve the dispute by mediation. Are you ready for starting mediation?*, becomes $u_0$ = {agree, attempt, be, dispute, mediation, solve, start, thank, ready}. A word may appear in many utterance texts. On the other hand, a word which appears multiple times in an utterance appears only once in the set of words in eq.(2).

### B. Graphical Diagram

A graph-structured diagram is employed here to represent the dialog $\boldsymbol{d}$ visually. Two characteristic structures are extracted from the time sequence pattern of word appearance in $\boldsymbol{d}$. The first structure is a temporal topic cluster. It is a group of words whose time sequence pattern of appearance is similar. The cluster is drawn as a sub-graph including nodes representing words and links representing strong similarity between words.

The second structure is an inter-topic association. The ability to extract the inter-topic association is the strength of our proposed method described in II-C and II-D. The inter-topic association corresponds to an utterance which can be a trigger to move from a temporal topic cluster to another. It does not necessarily mean a temporally adjacent relationship between 2 clusters. Rather, it may foreshadow the intentional or unintentional subsequent development of topics indicated by clusters which are far apart in time. The inter-topic association is drawn as a set of links between multiple temporal topic clusters. The set of links has a label pointing to a trigger utterance.

Fig. 1 shows an example of a graph-structured diagram which represents temporal topic clusters and inter-topic associations in the recorded utterance texts in a dialog. The cluster $c_0$ includes 3 words and $c_1$ includes 6 words. The association is a link between $c_0$ and $c_1$ which is labeled as DE0 pointing to $u_0$. The gateway word is the word in a cluster to which the link representing an inter-topic association is connected. For example, the word *mediation* is the gateway word to $c_0$ for DE0 ($u_0$).

The diagram uses the spring model [3] as a graph-drawing method. The spring model converts the strength of the relationship across the link between two nodes into Hooke's constant of the spring, which is placed between the nodes imaginarily, and calculates the equilibrium position of the nodes.

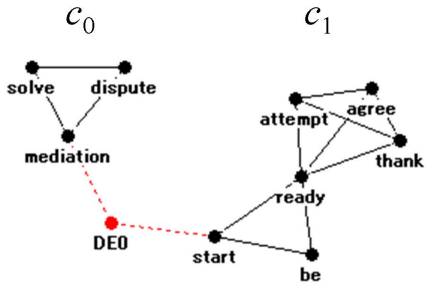


Fig. 1. Example of a graph-structured diagram which visualizes temporal topic clusters ($c_0$ and $c_1$), and inter-topic associations (DE0) found in the recorded utterance texts in a dialog. The nodes *mediation* and *start* are gateway words of the clusters.

### C. Temporal Topic Cluster

Every word $w_i$ which appears in $\boldsymbol{d}$ is classified into temporal topic clusters. The number of clusters $C$ is given. The number of clusters is interpreted as the granularity of reflection. As the granularity becomes finer, $C$ increases, the number of words in a cluster decreases, the time difference between neighbor clusters decreases. At first, a simple measure is introduced to characterize the time sequence pattern of word appearance. The characteristic time of a word is defined by eq.(3). It is the average of the time when a word appears.

$$a(w_i) = \frac{\sum_{t=0}^{T-1} tB(w_i \in u_t)}{\sum_{t=0}^{T-1} B(w_i \in u_t)} \tag{3}$$

The function $B(s)$ is define by eq.(4).

$$B(s) = \begin{cases} 1 & \text{if the statement } s \text{ is true} \\ 0 & \text{otherwise (false)} \end{cases}. \tag{4}$$

The similarity between 2 words is defined by eq.(5). The function $\min$ is included to avoid divergence of the similarity when the characteristic time is very close. Two words appear closely in time if the similarity is large. Eq.(5) measures the degree of similarity in temporal appearance pattern while the Jaccard coefficient used in text analysis [7] measures the degree of co-occurrence.

$$I(w_i, w_j) = \min(\frac{1}{|a(w_i) - a(w_j)|}, 1). \tag{5}$$

Then, a clustering algorithm for discrete objects is applied for given $C$. The k-medoids algorithm is a simple example [4]. A medoid is an object that is the closest to the center of gravity in a cluster. Its principle is similar to that of the k-means algorithm [2] for continuous numerical variables where the center of gravity is updated repeatedly according to the expectation-maximization method [1]. The distance between words is evaluated by the similarity in eq.(5). Initially, the words are classified into clusters at random in the k-medoids algorithm. The cluster into which a word $w_j$ is classified is denoted by $c(w_j)$. It is given by eq.(6).

$$c(w_j) = \text{random interger} \in [0, C-1]. \tag{6}$$

The medoid $w_{\mathrm{med}}(c_k)$ of a cluster $c_k$ is also assigned at random. It is given by eq.(7).

$$w_{\mathrm{med}}(c_k) = \text{random word} \in c_k \ (0 \leq k < C). \tag{7}$$

The clusters into which words are classified and the medoids are updated repeatedly. The cluster into which a word is classified is updated according to eq.(8). The operator arg in Equation (8) means that $c(w_j)$ is the cluster which gives the largest $I(w_{\mathrm{med}}(c_k), w_j)$. of all the clusters.

$$c(w_j) = \arg \max_{c_k} I(w_{\mathrm{med}}(c_k), w_j). \tag{8}$$

The medoid is updated according to eq.(9). The operator arg in Equation (9) means that the medoid is the word $w_j$ classified into $c_k$, which maximizes $M(c_k, w_j)$.

$$w_{\mathrm{med}}(c_k) = \arg \max_{w_j \in c_k} M(c_k, w_j) \ (0 \leq k < C). \tag{9}$$

The quantity $M(c_k, w_j)$ in eq.(9) is given by eq.(10). The operator $\wedge$ means logical AND.

$$M(c_k, w_j) = \sum_{w_l \in c_k \wedge w_l \neq w_j} I(w_l, w_j). \tag{10}$$

After the medoids are determined, the clusters into which words are classified are updated according to eq.(8) again. Eq.(8), (9), and (10) are calculated repeatedly until their value converges. The characteristic time of a cluster is defined by eq.(11). The time when a topic cluster $c_k$ appears is evaluated by the time when its medoid word appear approximately.

$$a(c_k) = a(w_{\mathrm{med}}(c_k)) \tag{11}$$

### D. Inter-topic Association

Next to extracting temporal topic clusters, every utterance is assigned a score which measures the degree of being an inter-topic association. The score $s(u_t)$ of the utterance $u_t$ is calculated by eq.(12).

$$s(u_t) = \max_{w_i \in u_t} \sum_{c_k} \max_{w_j \in c_k \wedge w_j \neq w_i} I(w_i, w_j). \tag{12}$$

The utterances which are assigned large value of the score are extracted to draw on a diagram. The utterance which has the $l$-th largest score is given by eq.(13).

$$U(\boldsymbol{d}, l) = \arg \max_{u_i \neq U(\boldsymbol{d}, m) \text{ for } {}^\forall m < l} s(u_i). \tag{13}$$

A gateway word of a cluster is selected when $U(\boldsymbol{d}, l)$ is drawn as a link between clusters on a graph. It is given by eq.(14). The operator arg means that the gateway word $w_{\mathrm{gtw}}(l, c_k)$ of a cluster $c_k$ for the utterance of the $l$-th largest score is the word $w_j \in c_k$ which maximizes $I(w_i, w_j)$.

$$w_{\mathrm{gtw}}(l, c_k) = \arg \max_{w_j \in c_k} \max_{w_i \in U(\boldsymbol{d}, l)} \sum_{c_{k'}} \max_{w_j \in c_{k'} \wedge w_j \neq w_i} I(w_i, w_j). \tag{14}$$

A set of links are drawn between the gateway words $\{w_{\mathrm{gtw}}(1, c_k)\}$ $(0 \leq k < C)$ for the utterance assigned the largest value of the score $(u_t = U(\boldsymbol{d}, 1))$ on a diagram. The label DE$t$ indicating $u_t$ is attached to the links. Similarly, a set of links are drawn between the gateway words $\{w_{\mathrm{gtw}}(l, c_k)\}$ $(0 \leq k < C)$ for the utterance assigned the $l$-th largest value of the score $(u_t = U(\boldsymbol{d}, l))$.

## III. Experiment

### A. Mediation case

The method described in II is applied to a dialogue recorded in a mediation training program. The disputed matter in the program is on a purchase transaction at an online auction site. Three mediation trainees played mediator and disputant roles. Their utterances until the dispute is resolved were recorded and assembled into a dialogue.

*1) Disputed Matter:* The disputed matter is on cancelling a purchase transaction at an online auction site. A seller offered a car muffler for bid at the auction site. The seller provided bidders with photographs of the muffler and showed them its condition and vendor information. A buyer won the bid 7 days later. The buyer paid for 20,000 yens another 2 days later, and the seller sent the muffler to the buyer. The transaction at the auction site completed.

After 2 and half months, the buyer asked the seller whether the muffler is made of stainless steel or aluminum-plated steel. The seller answered that the muffler is made of aluminum-plated steel as the photographs at the auction site had indicated. But, all the mufflers found at the vender's web catalogue were made of stainless steel at the time of bidding. A muffler made of stainless steel is expensive, but excellent in quality. The muffler which the seller sent to the buyer was not hallmarked by the vendor. The buyer became disappointed at these. The buyer requested that the purchase transaction be cancelled and the paid money be returned. The seller rejected the buyer's request. The buyer put a low rating score to the seller at the auction site. The seller did similarly in return. These low rating scores had made both of them untrustworthy at the auction site.

*2) Resolution:* The buyer disputant asked the seller disputant to attempt to resolve their dispute by mediation. The seller disputant agreed. With the aid of a mediator, the disputants talked about the secret facts on each side.

The seller disputant had bought the muffler at the same auction site before. The seller disputant was not aware that the vender did not supply mufflers made of aluminum-plated steel at the time of bidding. The seller disputant investigated the muffler after the buyer requested cancellation. The seller disputant found that it was a custom-made muffler from the vendor. The seller disputant was embarrassed by the low rating score, which harmed the seller disputant's business convenience. The seller disputant did not possess cache, but a number of mufflers, at the time of mediation. The buyer disputant had not tried to check the quality of the sent muffler for a long time. The buyer disputant had trouble with a car because of the insufficient quality of the sent muffler, and wanted to settle the trouble by all means.

Finally, they reached an agreement although the buyer disputant's original request on returning the paid money was thrown away in the mediation. The agreement is to substitute

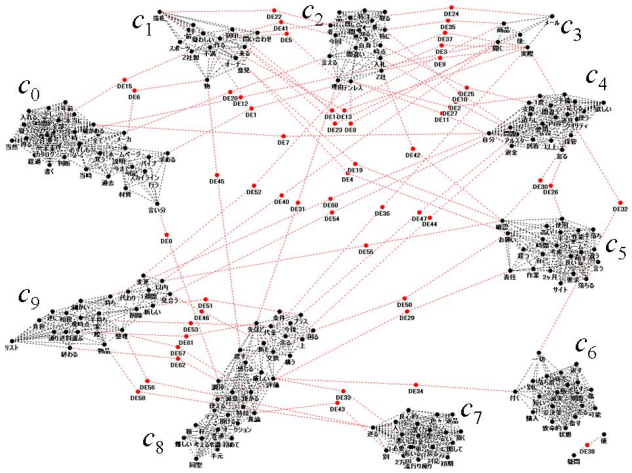


Fig. 2. Diagram drawn from the dialogue by the method in II which includes the inter-topic associations which are found within the whole utterances. The number of temporal topic clusters is $C = 10$. They are placed clockwise from $c_0$ to $c_9$. The words represented by nodes are in Japanese. The inter-topic associations are labelled by DE$i$.

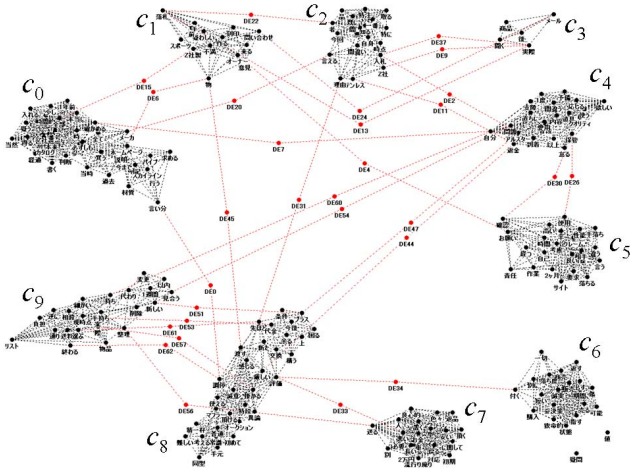


Fig. 3. Diagram drawn from the dialogue by the method in II which includes the inter-topic associations which are found within the utterances from the mediator. The temporal topic clusters are the same as those in Fig. 2. The words represented by nodes are in Japanese.

TABLE I
CONTENT OF THE TEMPORAL TOPIC CLUSTERS WHICH APPEAR IN FIG. 2. THE TIME WHEN A CLUSTER $c_k$ APPEARS IS DETERMINED BY THE REPRESENTATIVE VALUE OF $a(c_k)$ IN EQ.(11) APPROXIMATELY.

| Cluster | Time | Content |
|---|---|---|
| $c_0$ | 14 | About the buyer disputant's request that the purchase transaction be cancelled because the buyer disputant suspects of the quality and genuineness of the sent muffler. |
| $c_1$ | 19 | About the disputants' discussion on whether the muffler was really from the vendor. |
| $c_2$ | 22 | About the seller disputant's information that the muffler is custom-made. |
| $c_3$ | 25 | About the inquiry from the buyer disputant with an email. |
| $c_4$ | 28 | About the buyer disputant's complaint that the quality of a muffler made of aluminum-plated steel is not satisfactory. |
| $c_5$ | 32 | About the buyer disputant's admission that the buyer disputant did not try to check and use the sent muffler for a long time. |
| $c_6$ | 39 | About the solution which the buyer disputant proposed. |
| $c_7$ | 43 | About the buyer disputant's unawareness that the buyer disputant did not mind that the price of the offered muffler is inappropriately low as a muffler made of stainless steel at the time of bidding. |
| $c_8$ | 45 | About the seller disputant's admission that the seller was embarrassed because of the low rating score. |
| $c_9$ | 60 | About the seller disputant agrees that the muffler made of aluminum-plated steel will be substituted by another in exchange for the deletion of the low rating score at the auction site. |

TABLE II
NUMBER OF THE INTER-TOPIC ASSOCIATIONS BETWEEN THE TEMPORAL TOPIC CLUSTERS WHICH ARE FOUND WITHIN THE UTTERANCES FROM THE MEDIATOR (IN FIG. 3). FOR EXAMPLE, THE NUMBER OF THE ASSOCIATIONS BETWEEN THE CLUSTERS $c_4$ AND $c_9$ IS 2. THE TOTAL IS THE SUM OF THE NUMBERS IN A COLUMN.

| | $c_0$ | $c_1$ | $c_2$ | $c_3$ | $c_4$ | $c_5$ | $c_6$ | $c_7$ | $c_8$ | $c_9$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $c_0$ | - | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| $c_1$ | 2 | - | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 0 |
| $c_2$ | 1 | 1 | - | 2 | 2 | 0 | 0 | 0 | 1 | 0 |
| $c_3$ | 0 | 2 | 2 | - | 0 | 0 | 0 | 0 | 0 | 0 |
| $c_4$ | 1 | 0 | 2 | 0 | - | 2 | 0 | 0 | 2 | 2 |
| $c_5$ | 0 | 1 | 0 | 0 | 2 | - | 0 | 0 | 0 | 0 |
| $c_6$ | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 1 | 0 |
| $c_7$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 1 | 1 |
| $c_8$ | 1 | 1 | 1 | 0 | 2 | 0 | 1 | 1 | - | 5 |
| $c_9$ | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 5 | - |
| Total | 5 | 7 | 7 | 4 | **9** | 3 | 1 | 2 | **12** | **8** |

the muffler by another. The compromise solution is as follow. The buyer disputant would send the muffler back to the seller disputant. Instead, the buyer disputant would choose one of the mufflers which the seller disputant possessed, and the seller disputant would send the chosen muffler to the buyer disputant. Both of the low rating scores at the online auction site would be deleted by the disputants.

### B. Visualization

Fig. 2 is a diagram drawn from the dialogue by the method in II which includes the inter-topic associations which are found within the whole utterances. The number of temporal topic clusters is $C = 10$. In this case, the authors choose the number of clusters. This granularity is convenient for the authors to understand the temporal topic clusters. It may be more suitable that the mediation trainees who are supposed to reflect on their utterances choose the number of clusters according to the granularity of their understanding of the dialogue. The clusters are placed clockwise from $c_0$ to $c_9$. The words are in Japanese. TABLE I shows the interpreted content of the temporal topic clusters which appear in Fig. 2. The time when a cluster $c_k$ appears is determined by

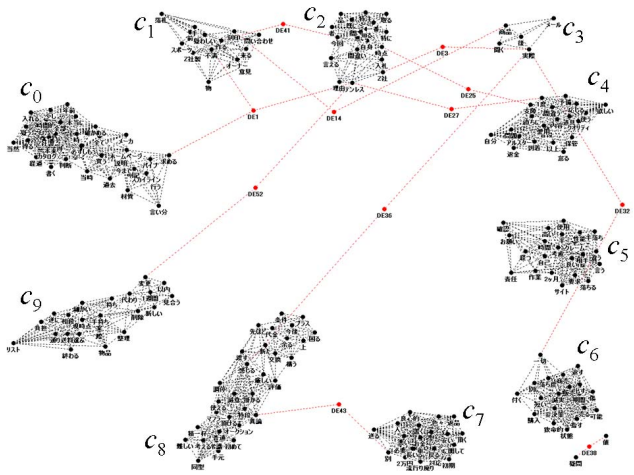


Fig. 4. Diagram drawn from the dialogue by the method in II which includes the inter-topic associations which are found within the utterances from the buyer disputant. The words represented by nodes are in Japanese.

TABLE III
NUMBER OF THE INTER-TOPIC ASSOCIATIONS BETWEEN THE TEMPORAL TOPIC CLUSTERS WHICH ARE FOUND WITHIN THE UTTERANCES FROM THE BUYER DISPUTANT (IN FIG. 4).

| | $c_0$ | $c_1$ | $c_2$ | $c_3$ | $c_4$ | $c_5$ | $c_6$ | $c_7$ | $c_8$ | $c_9$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $c_0$ | - | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $c_1$ | 1 | - | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| $c_2$ | 1 | 2 | - | 1 | 2 | 0 | 0 | 0 | 0 | 1 |
| $c_3$ | 0 | 1 | 1 | - | 0 | 0 | 1 | 0 | 1 | 0 |
| $c_4$ | 0 | 0 | 2 | 0 | - | 0 | 0 | 0 | 0 | 0 |
| $c_5$ | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 |
| $c_6$ | 0 | 0 | 0 | 1 | 0 | 0 | - | 0 | 0 | 0 |
| $c_7$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 1 | 0 |
| $c_8$ | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | - | 0 |
| $c_9$ | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Total | 2 | **4** | **7** | **4** | 2 | 0 | 1 | 1 | 2 | 1 |

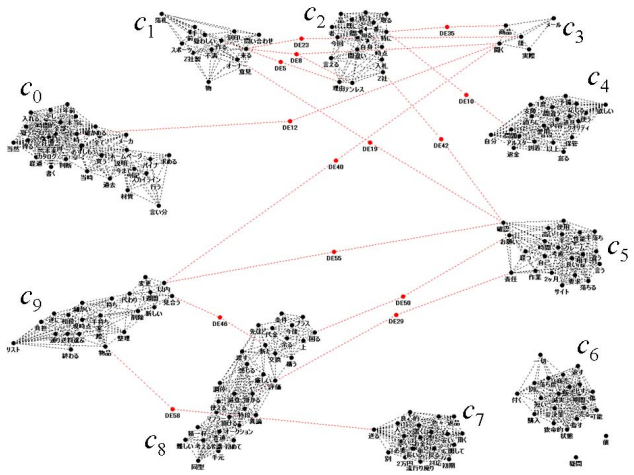


Fig. 5. Diagram drawn from the dialogue by the method in II which includes the inter-topic associations which are found within the utterances from the seller disputant. The words represented by nodes are in Japanese.

TABLE IV
NUMBER OF THE INTER-TOPIC ASSOCIATIONS BETWEEN THE TEMPORAL TOPIC CLUSTERS WHICH ARE FOUND WITHIN THE UTTERANCES FROM THE SELLER DISPUTANT (IN FIG. 5).

| | $c_0$ | $c_1$ | $c_2$ | $c_3$ | $c_4$ | $c_5$ | $c_6$ | $c_7$ | $c_8$ | $c_9$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $c_0$ | - | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| $c_1$ | 0 | - | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |
| $c_2$ | 0 | 2 | - | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| $c_3$ | 1 | 2 | 1 | - | 0 | 0 | 0 | 0 | 0 | 1 |
| $c_4$ | 0 | 0 | 1 | 0 | - | 0 | 0 | 0 | 0 | 0 |
| $c_5$ | 0 | 1 | 1 | 0 | 0 | - | 0 | 0 | 2 | 1 |
| $c_6$ | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 |
| $c_7$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 1 |
| $c_8$ | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | - | 1 |
| $c_9$ | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | - |
| Total | 1 | **5** | **5** | **5** | 1 | **5** | 0 | 1 | 3 | 4 |

the representative value of $a(c_k)$ in eq.(11) approximately. Following the sequence of the topics, the dialogue until the dispute is resolved can be understood and reflected.

Fig. 3 is a diagram drawn from the dialogue which includes the inter-topic associations which are found within the utterances from the mediator. The temporal topic clusters are the same as those in Fig. 2. TABLE II shows the number of the inter-topic associations between the temporal topic clusters within the utterances from the mediator. There are many inter-topic associations around the all clusters. The mediator made an effort to combine the strength and weakness of the disputants to find a compromise solution. Particularly, there are many associations around the clusters $c_8$, $c_9$, and $c_4$. The utterances of the mediator associate many topics from the disputants with the agreement.

Fig. 4 is a diagram drawn from the dialogue which includes the inter-topic associations which are found within the utterances from the buyer disputant. TABLE III shows the number of the inter-topic associations between the temporal topic clusters within the utterances from the buyer disputant. There are many inter-topic associations around the clusters $c_2$, $c_1$, and $c_3$ while there are few associations around the clusters near the end of dispute resolution. The buyer disputant raised a dispute, but could not make much effective discussion which developed into agreement. A compromise solution which the buyer disputant proposed in the cluster $c_6$ was not successful to reach an agreement.

Fig. 5 is a diagram drawn from the dialogue which includes the inter-topic associations which are found within the utterances from the seller disputant. TABLE IV shows the number of the inter-topic associations between the temporal topic clusters within the utterances from the seller disputant. There are many inter-topic associations around the clusters $c_5$ as well as $c_1$, $c_2$, and $c_3$ (around which many associations were found for the buyer disputant). There are associations around the clusters near the end. Actually, the cluster $c_5$ is associated with the clusters $c_8$ and $c_9$. In the cluster $c_5$, the buyer disputant admits that the buyer disputant did not take responsibility on checking the sent muffler. This fact was important for them to make a compromise agreement.

### C. Expert's evaluation

We interviewed a juristic informatics expert (a professional who studies, develops, applies, and deals with the information related to the law) and asked the expert to evaluate how well the diagrams (Fig. 2 through Fig. 5) represent the development of topics until the dispute is resolved qualitatively.

The expert paid attention to the inter-topic associations around the cluster $c_6$ indicated in the diagrams. The cluster summarizes the solution which the buyer disputant proposed. The fact that the buyer disputant adhered to this solution made the cluster an impasse point where the dispute resolution had failed to develop. It is clearly indicated by the diagrams. The cluster $c_6$ has no associations to the clusters $c_7$ to $c_9$ in Fig. 4. The buyer disputant failed to develop the proposal toward an agreement. The cluster $c_6$ has no associations at all in Fig. 5. The seller disputant ignored the proposal. On the other hand, the mediator found within the discussions on the buyer disputant's proposal that the low rating score at the auction site can be a material to make the disputants compromise. It is indicated by an association between the clusters $c_6$ and $c_8$ in Fig. 3.

The expert said that the diagrams look useful for the mediation trainees to reflect on their discussions from the impasse point to the agreement. This is a qualitative evaluation on only a single mediation case. Although the experiment and evaluation are preliminary results, extracting and visualizing the inter-topic associations seem to present the potential ability to help understand how the dispute was resolved into a compromise solution.

## IV. Conclusion

We explored a text processing method for reflective visualization of the utterances from a mediator and disputants in a dialogue in mediation. The method visualizes inter-topic associations which foreshadows the intentional or unintentional subsequent development of topics indicated by temporal topics clusters far apart in time. The method is applied to a mediation case where a dispute between a seller and a buyer at an online auction site is resolved. The juristic informatics expert paid attention to the inter-topic associations, around an impasse point where the buyer disputant adhered to requesting cancellation to the seller disputant, which indicates the mediator' effort to find a material to make the disputants compromise. This implies that the diagrams are useful for mediation trainees to reflect on their dialogue to move from the impasse point to an agreement. Although the experiment and evaluation are preliminary, the concept of an inter-topic association is a potentially effective tool to help trainees reflect on the way how their utterances, decision-makings, and behaviors influenced on the conclusion of mediation.

Next, we need to carry out extensive experiments which evaluate the usefulness of the diagrams quantitatively. Practically speaking, it is important to show the diagrams to the mediation trainees, interview them on how they reflect on their utterances using the diagrams, and measure whether their skills are improved after the reflection. The opinions from many juristic informatics experts and experienced mediators are also relevant to test the mothod. The method can be applied to many kinds of conversations in business and social lives (other than a dialog in mediation). For example, it is beneficial to visualize the way how the opposing design ideas in a product design team is resolved and united into a single excellent design. Our method can be a basis to help people understand the knacks to resolve a conflict between parties having opposing opinions in many social problems.

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