Strategies for Creative Argumentation: Learned from Logs of Innovators Market Game

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Abstract. Based on cases of Innovators Market Game (IMG), a gamified workshop where each participant plays the role of an inventor who creates and proposes actions in business, or of a consumer who evaluates the quality of those proposals, we investigated how proposed ideas can be, or can be revised to be, acceptable via the workshop. The analysis in this paper has been conducted on the data of players' log of argumentation - indirectly observable on the gameboard where demands of consumers and proposed solutions of inventors are written reflecting the arguments in the workshop. We regard such an argumentation as a process to set the granularity of an argument suitable for putting into action. Based on the original constraint-based representation of classification of conflicts between a consumer and an inventor, that reflects the positions of latent constraints and intentions, we analyzed players' "written" log of argumentation in order to learn strategies for manipulating intentions and constraints of participants toward the creation of acceptable solutions.

1 Introduction: A Gamified Creative Argumentation

Innovators' Market Game (IMG) is a gamified approach where multidisciplinary elements (knowledge, technologies, and ideas) are coupled to create solutions to a social problem, i.e., a problem of common concern for the society. Here, the interaction among participants is conducted on a diagram visualizing the correlation of initially given elements (pieces of knowledge about technologies, products, services, etc) [2]. In this process, knowledge not initially given may be added to the elements, and hidden contexts or constraints will be discussed. As a result, open problems can be addressed although the workshop starts from a finite set of elements, prepared as cards on which titles and summaries of existing knowledge/technologies are printed. In IMG, each of about ten participants plays the role of an *inventor* or a *consumer*. Three or four play as inventors, who first buy a number of prepared cards. They combine these elements on a diagram visualizing available data about their co-occurrences [3, 4] to propose products or services. On the other hand, consumers evaluate, criticize, or buy the proposed ideas, and present demands reflecting real-life.

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Each consumer buys preferable solutions proposed by inventors, priced via negotiation. The richest inventor and the consumer having bought the solution-set of the highest value, according to the evaluation by other players, become the winners. In the negotiation, inventors seek to increase the price whereas consumers seek to discount, which urges consumers' demands/criticisms and inventors' trials to satisfy the requirements. However, if the requirements are beyond the given elements, inventors can add new elements to the original set paying extraordinary fee.

Although we do not take the established methodology of argumentation, we are interested in non-monotonic reasoning via the dynamic process of argumentation as proposed in [5-10]. That is, in that participants in IMG propose, evaluate, and also improve ideas via criticisms and conflicts [11], IMG can be regarded as a place for arguments with non-monotonic reasoning. And, the dialogue in IMG means to take the best among available solutions, after revising them with changing premises - i.e., available actions, situations, and criteria for evaluating ideas - similar to Atkinson's representation of practical argumentation [8]. Also, in argumentation studies, conflict resolution [9] and contextual shifts in theory-building dialogue [10] can be linked to creative revision of ideas via non-monotonic reasoning. IMG present a place of experiments for supporting this expectation, because it has been introduced for aiding innovations and creative problem solving for industrial/social profits [2].

Fig.1 shows an example result of IMG applied to creating strategies for maintaining the safety of aged nuclear plants. Players here discussed the utilities of solutions which were presented, written on stickers and put on the game board, by inventors. They also revised ideas to fit the requirements of consumers. The most frequently bought solution was *"Quantitative evaluation of plant reliability, by integrating the model of material deterioration and data on the damage of the system*" proposed by combining cards of *plant sensors for reinforcing observations* and *plant simulator for*

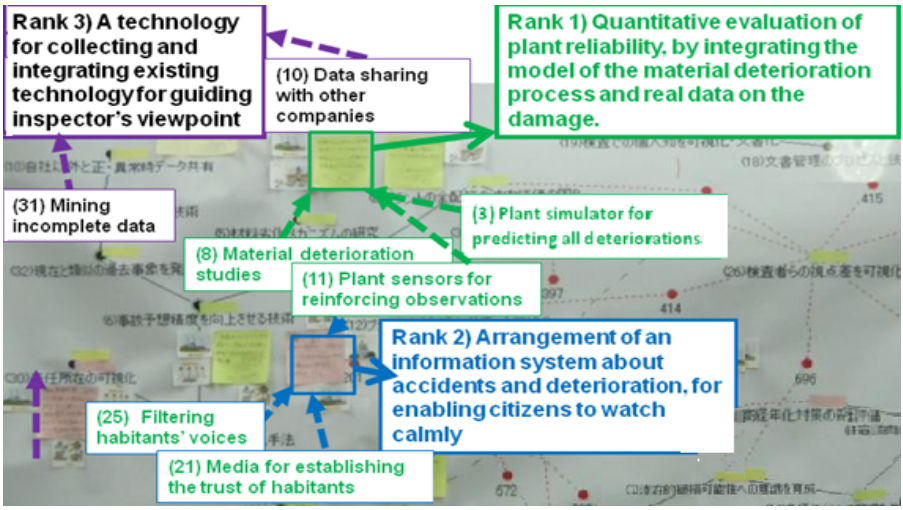

Fig. 1. A result of IMG, where demands and solutions are written on stickers put on the game-board, challenging the problem "how can we reinforce safety of aged nuclear plants?"

predicting deteriorations. The second best was the "*Arrangement of an information system about accidents and deterioration, for enabling citizens to watch calmly"* by combining the plant sensors above, *media for establishing the trust of habitants,* and *filtering habitants' voices.* For these top two ideas, plant sensors were used as an element to be combined, and came to be realized as business in 2013.

2 Argumentation in IMG

So far, we showed an idea proposed in IMG can be improved by criticisms [11]. For example, in the case above, *"Quantitative evaluation of plant reliability*" was proposed at once by combining cards *plant sensors* and *material deterioration studies.* This idea was attacked by a counter argument that sensors for detecting deterioration of each part of a plant does not necessarily work for checking the reliability of the plant as a large scale system, because the causality between using sensors and inspecting the plant reliability may not stand, for such a complex system. A manner for coping with this conflict may be to have the two arguments compete and see which of the two should be discarded. However, a more meaningful manner is to invent a situation where the two sides do not conflict. In the case above, the use of sensors was finally combined with choosing pipelines in the power plant essential for the deterioration of the whole system (this does not appear as a card in Fig.1).

We can position our work succeeding the meaning of *granularity*, that is the resolution by which human or computer distinguishes entities to deal with, for processing the information about them. Especially, when decision making and communication meaningful for the process is desired, granularity of information would be essential because too fine information is noisy and too rough information is useless. Thus, in this study we regard granularity as how finely available choices correspond to situations to be distinguished in decision making. In other words, we regard a solution proposed reflecting the finer level of situation of its user who is a consumer, or its creator who is an inventor, as of the higher granularity. In this sense, revising a solution via argumentation means a process to improve the granularity to a suitable level. Here, with the increase of granularity due to considering situations, the inconsistencies tend to be revealed, which motivates the revision of the solution.

In the case of Fig.1, however, the idea to choose essential pipelines was not included in the given elements or in the conversation just before the revision of proposal, but originally appeared at the starting of IMG. That is, the idea was not intended to attack the original proposal *"Quantitative evaluation of plant reliability.*" As in this example, premises to be considered and goals to be achieved for solving a problem are not always linked explicitly in the time sequence, but scatter over the period of conversation without explicit logical structure, which will then be structured by borrowing knowledge and ideas which may come from outside of the discourse.

The difference between previous studies on argumentation and this paper is motivated from such a case. That is, we here analyze the latent relationships among arguments in IMG by expressing the arguments as constraints that are static expressions of causalities between premises and goals, which may have been presented at remote

times. By this approach, we merely aim at understanding indirect dependencies of latent intentions and constraints, which may be externalized via the discourse. In the following, let us propose a logical model that explains causalities and conflicts between demands and solutions. Here we choose to use a Horn clause (simply *clause* hereafter) put simply as in (1), representing the static constraint between a result (the left hand side) and its conditions (the right). By this choice, we aim at simply expressing a constraint between an action e.g., "*I sell this car*" and its goal e.g., "*get one million dollar*" where we can consider other actions for realizing goal *g* by adding other conditions, that may be really satisfied at different times, in the form of constraints as Horn clauses. Moreover, we can consider various constraints including inconsistencies between actions and events with as simple expression as Horn clauses, as far as we do not aim to clarify dynamic effects of each action via dynamic derivation of new arguments in the course of thoughts or discussion (e.g., "*I infer, someone will appear soon to buy it for one million dollar, if I sell this car*").

$$g \text{ :- } a, \tag{1}$$

In clause (1), *g* and *a* respectively represent the demanded goal and an action or an event one should cause for realizing the goal. Both event/situation/action *a* and *g* can be represented by a proposition (hereafter we use both "proposition *a*" and "action(or event) *a*" as far as confusion is not caused), and clause (1) means *g* is true if *a* is true. For example, in the context of active media for medical care, let *g* be an aimed state "*patients communicate various doctors freely*" because some patients tend to desire second opinions from other doctors than primary doctors. Considering the cost for second opinions, Dr.X may consider action *a* that is "*Dr.X develops an SNS where patients can communicate doctors via the Web*" as a (candidate of) solution for *g*.

Below let us propose four types of conflicts, semantically similar to the classification of attacks in argumentation [8] but put in Horn clauses for constraint-based modeling. Let us show the expression of these constraints in a general form below. In the case of Type A, the conflict as a side effect of action *a* may be caused in a situation represented by u_A, as in empty clause (2). This empty clause means *a* and u_A are inconsistent, i.e., events represented by *a* and u_A cannot occur at the same time. Proposition u_A stands for a hidden event/situation that had been ignored until *a* came to be given as a possible action, but is expected to be true and hard to change, once it came to be noticed. As a result, action *a* comes to be forbidden. In Type B, *b* is a condition necessary for action *a*. In Type C, *c* is a required situation in addition to *a* for making goal *g* true. In Type B and C, u_B *versus b* and u_C *versus c* stand as inconsistent pairs as declared in clauses (4) and (6) respectively. As a result, action *a* cannot be taken in Type B, and goal *g* cannot be achieved by action *a* in Type C. Due to the represented constraints, *g* is negated as impossible in all three types of conflicts.

$$\begin{aligned}
&\text{(Type A)} && g \text{ :- } a; && && \\
&&& \text{:- } a, u_A. && && (2)\\
&\text{(Type B)} && g \text{ :- } a; && a \text{ :- } b; && (3)\\
&&& \text{:- } b, u_B; && && (4)\\
&\text{(Type C)} && g \text{ :- } a, c; && && (5)\\
&&& \text{:- } c, u_C. && && (6)
\end{aligned}$$

In Type D below, the goal can be achieved by action a. However, the result will not be accepted by the consumer who proposed the goal.

$$\text{(Type D)} \quad g \text{ :- } a; \qquad q \text{ :- } g, p. \tag{7}$$

$$\text{:- } u_D, a, p. \tag{8}$$

Here, q stands for the *intention*, or the latent and real requirement, of consumer R who demanded goal g. p stands for a hidden event supposed to be true in the mind of consumer R when he expressed "g :- a" but is not always so because of its inconsistency with event/situation u_D. In other words, R's real intention turns out not to be satisfied by realizing goal g. This is why the proposal of action a fails to be accepted. Note that all propositions (a, b, …p, .., u_C, u_D) may affect the arguments in over all the discourse, although they, except a and g, tend to be hidden or not to be highlighted in the daily life, whereas a and g are verbally spoken out and written. Therefore, as shown below, we developed a method to analyze the appearance of these four types of conflicts, without depending on analysis/visualization of sequential data of discourse.

3 Strategies for Consensus from Each Type of Conflict

In activities where feasible solutions are desired for social problems, involving human relations, we are bound in the network of actions, intentions, and constraints, because one's intention or constraint may affect others'. Thus, in requirement acquisition and innovations in industries, externalizing latent intentions and constraints behind an action of stakeholders is an essential step for designing products/services [12, 13].

Here let us define *manipulation* as externalization and/or control of actions, intentions, or constraints. For example, if Dr. X thinks of creating an SNS for his intention, the constraint for this action may be that Dr. X is occupied by his daily work to see patients, and that he has to employ technicians. However, if the causal structure of intentions and constraints are revealed, Dr. X may be enabled to manipulate, i.e., to control his own intention (e.g., release patients from anxieties about diseases), action (e.g., make a room for patients to talk with medical consultants and others, if necessary, face-to-face), or constraint (e.g., allowing patients to talk not only via the Web but also face to face), so that he can improve the situation. Below let us classify manipulations that are feasible (possible to do), in each type of conflict A, B, C, and D, for the example mentioned above where goal g is *"patients communicate various doctors freely*" and action a is "*Dr.X develops an SNS where patients can communicate doctors via the Web*", for all these types. See also Table 1.

Type A: We should consider to change a or u_A (e.g., "*patients do not like to communicate private issues on the Web*.") in order to be released from the conflict. Since we suppose u_A is hard to change, one should change action a to some other idea.

Type B: b may be a proposition such as "*Dr.X employs developers of Web-based communication system and medical doctors*" and u_B"*I do not have enough money for employing good developers"* causing a conflict in clause (4). u_B is hard to change,

so *b* should be changed into such an alternative method for action *a* as borrowing an existing Web service where a new SNS is easy to develop and finding voluntary doctors, that is a manipulation of constraints.

Type C: If u_C is explicitly shown out (by stakeholders worrying about side effects of *c*), its conflict with *c* and *c* itself are highlighted so that *g* :- *a* shall be replaced with *g* :- *a*, *c*. If u_C is impossible to prune or change, *a* as an action meaningful only if *c* is true should be pruned from the proposal because clause (6) forbids *c*. Otherwise, *c* may be replaced with *c'* consistent with u_C. For example, let *c* mean "*doctors and patients understand each other via the Internet"* which clearly contradicts u_C"*doctors and patients cannot understand each other via the Internet.*" u_C may be hard to change, but we may change *a* into "*Dr.X develops an SNS for medical consultants on the Web and patients to communicate"* and *c* into *c'* "*medical consultants on the Web and patients understand each other via the Internet"* which is not inconsistent with u_C. Accordingly, *g* can be revised into "*patients communicate various medical consultants on the Web freely*". Thus, a conflict of Type C can be managed by manipulating the condition, such as targeting different customers.

Type D: Let *g* again be "*patients communicate various medical doctors on the Web freely*". An empathetic communication may console patients, but empathy is not always in the communication in SNS. That is, the intention *q* behind *g* is to have "*patients feel released from anxiety*," and *p* is "*empathetic communication*" not expected because of inconsistency with u_D *"empathy is not expected in an SNS environment between doctors and patients*" combined with *a* as in clause (8). One choice is to replace *g* in clause (7) with *q* to propose a solution for *q* instead of *g*. As the second, one may try to make *g* true, and relax the constraint in the empty clause (8). For the example, *p* as "*empathetic communication*" may be realized by SNS if members can also meet face-to-face. This means to add a condition d_D"*if members have no opportunity to meet face to fac*e" to u_D in empty clause (8) for relaxing the inconsistency between *a* and *p*, i.e, to make clause (9) and notice *q* can be realized by combining action *a* and a method to enable SNS members to meet face to face:

$$:- u_D, d_D, a, p. \tag{9}$$

Thus, for cases of Type D, we can manipulate the goal, i.e., shift the goal to the revealed intention or find exceptions for the constraint. Note u_D here is easier to change than u_A mentioned previously, because u_D tends to be less necessary than u_A that is promptly noticed on proposing *a* – this is why exceptions can be found.

4 Experiments: Information on the Board of IMG

Here we conducted six cases of IMG, where 12, 16, 30, and 44 (3 games) cards of elements were used respectively and 8 to 11 participants attended. Each game took 90 to 120 minutes, and, as a result, 17 (14), 19 (15), 13 (7), and 31 (24), 14 (13), 14 (13), solutions (demands) were presented on stickers by inventors (consumers).

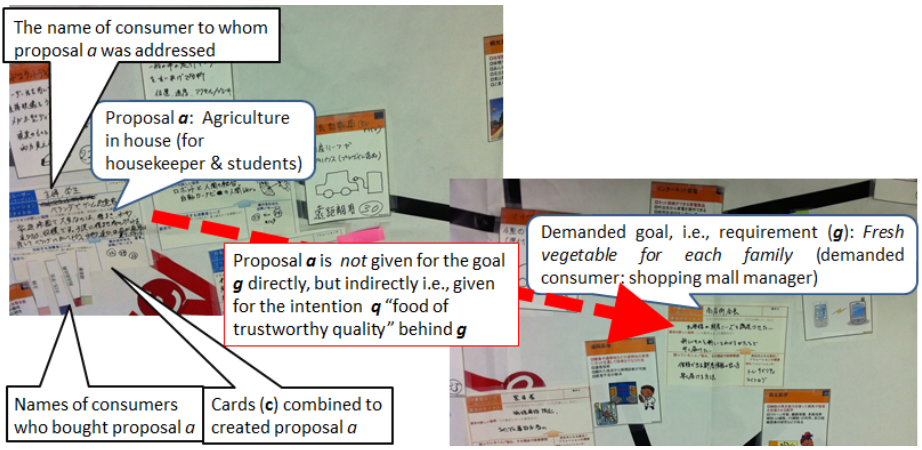

Fig. 2. Solutions as responses to demands: In cases of IMG (executed in 2013)

After playing IMG, we read the demands and solutions on the filled stickers and their positions on the board because the intentions, constraints, or the relevance between them tended not to appear in oral utterances – as we mentioned in Section 1. Transactions in IMG observed as words written on stickers are here as regarded as the log of arguments as in Fig.2. On the stickers, we could investigate how each consumer's demand (corresponding to goal g, or q in clause (7) if a new sticker was added onto a sticker for g) was responded by an action (i.e., a) proposed by an inventor with combining elements on cards (i.e., b in clause (3)), since inventors had been instructed to write "a: b_1, b_2, …b_m") if a was proposed by combining elements b_1, b_2, …b_m. Also we checked to whose goal each proposal was addressed, by reading the name of the target consumer written on the proposal sticker (as in the left-hand of Fig.2), or if the proposal obviously matched with a closely put demanding sticker on the game board. If multiple similar proposals were put close to each other, combining similar elements, we regarded them as revisions of the same proposal. For example, if consumer R shows a demand for goal g but inventors' proposal does not satisfy him, a conflict of some type occurs, i.e., its potential conflict with the surrounding situation (Type A), weak feasibility (B), gap with R's situation (C) or intention (D).

Table 1. Types of conflicts, and policies for consensus: Fo X(Y) in the last row, X is the number of conflicts in each type, followed by manipulations, and Y success cases among X

	Type A	Type B	Type C	Type D
Observable policy for coping with a conflict	No policy is expected	Change a using new methods, i.e., new elements, and put the new action close to a	Sell action a as a solution to others than R (R: the consumer who demanded g).	Put a new goal close to g, or change a without changing the method
No. of manipulations	Unobservable	5 (2)	**28 (27)**	13 (8)
		Note: The total number of proposals was 108		

If so, the proposal should be revised as in the first row of Table 1, according to the conflict type. Such a manipulation is observed as words on and positions of stickers and regarded as an evidence of the conflict type, whereas a conflict itself maybe hidden behind successful transactions – consumers may buy even if conflicts are not perfectly solved.

5 Results: Patterns toward Creative Consensus via Conflicts

5.1 Four Types of Policies for Coping with Conflicts

Conflicts followed by manipulations of intentions/constraints/actions, as observed on stickers, were classified manually. As a result, classification of 46 cases into Types B, C, or D came to be obtained. As in the last row of Table 1, the frequency of applying the manipulation policy for reaching consensus after conflicts of Type C, i.e., targeting unexpected consumers, came to be the largest (=28), as well as its success probability (=27/28). The next most frequent and successful type was Type D, where inventors tried to understand and satisfy the latent intention of R. Thus we obtained the following two strategies for making acceptable solutions. These two can be unified into one strategy, that is to understand consumers' latent intentions, which may be shared by other segments of consumers.

Str. 1) Consider new consumers, rather than focusing on originally aimed consumers.

Str. 2) Consider the real intention of consumers, not only the demanded goals

Thus, a policy to cope with conflicts can be extended, from sheer coping with inconsistency, to a creative activity increasing the satisfaction in the market.

5.2 Patterns toward Successes and Failures in Consensus

Furthermore, we analyzed the data of arguments in experiments as follows: First, we symbolized the process of argumentation for each proposed action as:

$$[G/Ng]: [S/F], U_1 \text{ -> } [S/F], U_2 \text{ -> } [S/F], \ldots, U_n \text{ -> } [S/F], \quad (10)$$

where the first term [G/Ng] means if the inventor explicitly considered a demand of a consumer ('G') or not ('Ng'), according to the solution put on the game board. [S/F] in the following part of this line represents success ('S') or failure ('F'), and U_i (i=1,2,…or n), means a type of manipulation corresponding to a type of conflict in Table 1 (ranging over A, B, C, and D). For example, the statement "G: F, B -> S, C -> S" means the idea was first presented considering to satisfy a goal presented by a consumer as 'G' shows, but the effort was not successful as the next 'F' shows. Then, as "B -> S, C -> S" shows that the proposed action was bought when methods for the proposed action were revised by changing the cards combined (as "B -> S" shows), and the new proposal was finally bought also by others than the expected consumer who originally demanded the goal ("C -> S"). On the other hand, "B -> F" occurs, if the demanding consumer of a goal does not buy the solution revised with new cards.

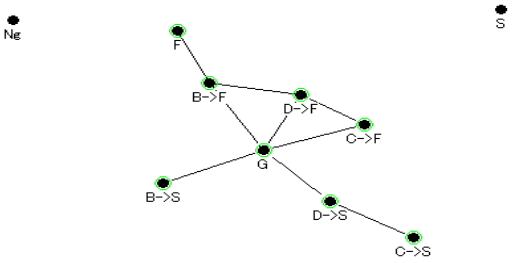

Fig. 3. Relations among goal-orientedness ('G' or 'Ng'), manipulation policies ('B', 'C', 'D'), and success/failure ('S'/'F') in the argumentation about 108 proposed actions for six IMG cases. Each line represents a correlation between 'G', 'Ng', 'F', 'S', 'B', 'C', and 'D'. 'A' does not appear since policies for managing Type A are not proposed in this paper.

As a result, the collected data can be listed as follows, where each line represents the argumentation for evaluating or revising a proposed action:

Sequence = G: S,
G: D -> F,
Ng: F,
G: S, C -> S.
….
(11)

Fig.3 visualizes the relations among items in the real data listed like Eq.(11) – the real data had 108 lines corresponding to proposed actions. Each line in Fig.3 represents a correlation between G, Ng, F, S, A, B, C, and D mentioned above, drawn using the following function:

$$link(X, Y) = p(X \text{ and } Y)/p(X)p(Y). \quad (12)$$

This is a simplified mutual information, and nine pairs of the largest values of *link* are connected in Fig.3. The function in Eq. (12) has been chosen because the latent ideas and unspoken interests may cause players to pay attention to arguments in IMG, and that this function has been known to represent the impact of the latent cause. From Fig.3 we find patterns from which, for example, we learn the two strategies below:

Str. 3) Target new consumers in order to reach success (represented by "C->S"), after considering latent intentions behind the demanded goal ('G') turns into a success ("D->S"). This works according to the position of "D->S" between 'G' and "C->S", and corresponds to the merging of Strategy 1 and Strategy 2.

Str. 4) Do not revise methods for an action, if the action was once proposed for a certain goal ('G') but rejected at first ('F') by the corresponding consumer - because such a revision seldom works, as "B->F" between 'G' and 'F' shows.

6 Conclusions

We analyzed experimental cases of Innovators Market Game (IMG), as an active place for exchanging creative arguments, focusing on the matching of goals demanded by consumers and actions proposed by inventors. We first regarded the improvements of inventors' ideas as a way for resolving conflicts between consumers and inventors in the argumentation, and then extended this idea to make applicable to analyzing discourses in IMG. Based on the log analysis of behaviors of IMG players, with reflecting the proposed classification of policies for coping with conflicts via the manipulation of intentions and constraints, we came to present strategies for argumentation toward creating solutions acceptable in the market.

As we used for examples, applying active media for medical care services are likely to cause conflicts because it is a creative combination of up-to-date technologies and an existing domain where conservative culture may remain. We will develop a finer typology of creative arguments, for refining the strategies obtained in this paper to be applicable to argumentations about a cutting edge of creativity. Missing the space for acknowledgement, let us here express thanks to participants of IMG.

References

1. Mohammed, S., Ringseis, E.: Cognitive Diversity and Consensus in Group Decision Making: The Role of Inputs, Processes, and Outcomes. Organizational Behavior and Human Decision Processes 85(2), 310–335 (2001)
2. Ohsawa, Y., Nishihara, Y.: Innovators' Marketplace: Using Games to Activate and Train Innovators. Springer (2012)
3. Ohsawa, Y., Benson, N.E., Yachida, M.: KeyGraph: Automatic Indexing by Co-occurrence Graph based on Building Construction Metaphor. In: Proc. Advanced Digital Library Conference, IEEE ADL 1998, pp. 12–18 (1998)
4. Ohsawa, Y., McBurney, P.: Chance Discovery. Springer (2003)
5. Dung, P.M.: On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. Artificial Intelligence 77(2), 321–357 (1995)
6. Walton, D.: Media argumentation – Dialectic, Persuasion, and Rhetoric. Cambridge University Press (2007)
7. Bench-Capon, T.J.M., Prakken, H.: Justifying Actions by Accruing Arguments. In: Proceedings of the 2006 Conference on Computational Models of Argument, pp. 247–258 (2006)
8. Atkinson, K., Bench-capon, T., McBurney, P.: Computational representation of practical argument. Synthese 152, 157–206 (2006)
9. Kowalski, R.A., Toni, F.: Argument and Reconciliation. In: Proceedings of Workshop on Legal Reasoning International Symposium on FGCS (1994)
10. Prakken, H.: Argumentation without arguments. Argumentation 25, 171–184 (2011)
11. Nishihara, Y., Ohsawa, Y.: Communication Analysis focusing Negative Utterances in Combinatorial Thinking Games. The Review of Socionetwork Strategies 4(2), 31–46 (2010)
12. Goldratt, E.M.: Essays on the Theory of Constraints. North River Press (1987)
13. Ohsawa, Y., Akimoto, M.: Unstick Tsugoes for Innovative Interaction of Market Stakeholders. Int'l Journal on Knowledge and Systems Science 4(1), 32–49 (2013)