A Proposal of a Structuring Notation for a Judgement

Tatsuki Kawasaki, Sosuke Moriguchi, and Kazuko Takahashi

School of Science&Technology, Kwansei Gakuin University,
2-1, Gakuen, Sanda, 669-1337, JAPAN
dxk96093@kwansei.ac.jp, chiguri@acm.org, ktaka@kwansei.ac.jp

Abstract. This paper proposes a new graphical representation for a judgement. The representation is based on the form of the existing goal structuring notation (GSN). Most of current representations for a systematic treatment of judgment show the argumentation process which consists of attack and support relations. In contrast, we propose a notation without attack relations, focusing on the fact that the final judgement statement can be described by a sequence of positive (supporting) claims without negative (attacking) claims. GSN shows an evidence-based reasoning in which derivation from the evidences to the conclusion is clarified. We propose two kinds of notations based on GSN, and illustrate that they can make people easy to understand the structure in which final decision is supported by claims at a glance.

Keywords: argumentation, evidence-based reasoning, GSN, Toulmin model

1 Introduction

A number of studies on computational legal reasoning using logic have been done, since legal documents contain a lot of logical factors. However, legal documents are not fully digitized in Japan, and the methods of their systematic treatments are not sufficiently developed. Both judgement records and judgement sentences are written in a natural language without being structured. The judge makes a decision based on the presented evidences and a judgement contains the conclusion and the grounds which led the judge to form their conclusion. However, the final decision is actually made in a personal mind of the judge without documenting and how the conclusion is derived is not shown clearly. As a result, it is difficult for a person who are not familiar with a law to fully understand the reason to derive the conclusion in the disclosed text of judgement.

In the citizen judge system that was introduced in 2009 in Japan, the general citizens should make argumentations to achieve an agreement. Considering such situations, a structured document is needed which can give a sufficient account for the way of deriving the conclusion and the approved evidences that affect the derivation. It follows that it is eagerly required to develop a method to structuring an argumentation with its visualization on a computer.

To solve this problem, there are several approaches. One of them is a PROLEG system that facilitates the representation of a law [11]. It was designed to support inferences based on the Japanese Presupposed Ultimate Facts Theory of the Japanese civil code. In PROLEG, a law is written in a form of logic program and reasoning process is visualized using a block diagram.

Another approach is to give a structured representation using an abstract argumentation framework [3], and a bipolar argumentation framework (BAF) [1]. In BAF, there are two types of relationships between arguments: support and attack. It is advantageous on representing the interaction between a plaintiff and a defendant in court by regarding a claim as a support, and a defense as an attack between arguments. Kawasaki et al. showed a transformation from a PROLEG program to a BAF [8]. There are other proposals that apply an argumentation to give a structured representation to judgement [2, 16].

However, these existing methods have two drawbacks.

The one is that it is not easy to grasp requirement facts and evidential facts to derive the conclusions on these representations. Both a block diagram and BAF consist of two kinds of arguments: claims (supports) and defenses (attacks). While the argumentation-based approach is suitable to handle conflicts, appearances of the arguments on both sides together may interrupt to grasp the derivation process of a specific requirement.

The other is that the process of fact finding is usually out of their focus. The conditions for the law to be effective are represented, but for the evidential fact to approve the requirement, only its existence or absence is represented; the reason why a fact is admitted as an evidence is not represented. For example, a law for a crime of murder tells that if (i) the object is a human (not a dead body) and there exist both (ii) the action of murder and (iii) the intention to murder, then the crime of murder has been committed unless (iv) there is a legitimate defense. When an evidence is provided, it is assumed that the facts on which that evidence bears are proved. If all the evidences for the requirements (i)–(iii) are approved and that for the requirement (iv) is not, then the crime of murder is effectively applied. In this case, how is a fact "action of murder" approved? In Japanese judgement, the process of fact finding is crucial especially in a criminal case. Although a final judgement depends on the judge's belief on the credibility, it is said that circumstantial evidence should be adopted rather than confession or testimony. Criteria of a fact finding from circumstantial evidences is discussed in some works (e.g., [7]), but currently no general basis exists.

To cover these drawbacks, we propose a graphical representation only with support relations as a complement of existing representation based on argumentation framework. It is based on Goal Structuring Notation (GSN) [9, 5, 10, 14].

Argumentation models have been also proposed in software development in recent twenty years. They are used to show safety, security or assurance of a safety-critical software. GSN for representing an assurance case is one of the most familiar argumentation models which was inspired by a Toulmin model [13, 6]. It is a structured document which persuades the stakeholders that the requirement

is completely satisfied by showing what are evidences and how they are used to derive the overall claim.

This concept can be applied to an argumentation in a criminal case. The judgement is evidence-based and the requirement should be checked with evidences in various aspects. In addition, it can be considered to be safety-critical, since the judgement is done based on the idea "if there is a doubt, then the person should not be punished."

In this paper, we propose two kinds of graphical representations: *structuring notation for applying law (SNAL)* and *structuring notation for fact finding (SNFF)* based on GSN. It can be used to clarify the factors to make a law effective and to structure them under an ambiguous situation. Our aim is to provide a structured document to make an account for the derivation process of a final decision of a judgement from evidences. We do not discuss the evaluation of the derivations.

This paper is organized as follows. In Section 2, we explain the concept and overview of GSN. In Section 3 and in Section 4, we present two new graphical notations for judgement based on GSN, and show their examples. In Section 5 we compare our method with those of others. Finally, in Section 6, we show conclusions and describe future work.

2 Goal Structured Notation

Toulmin proposed a model for argumentation [13, 6]. In this model, an argument consists of the grounds (data), claim and warrant. The grounds is the evidence used to prove a claim. The warrant is the assumption or principle that connects the grounds to the claim. Backing and qualification may be added in case. The relation between these elements and also that of multiple arguments are shown as a diagram.

GSN is a graphical argumentation notation [9] which is inspired by a Toulmin model. It is a document for an assurance case of a safety-critical software such as railways and aerospace [10]. In assurance cases, an argument is defined as a connected series of claims intended to establish an overall claim.

GSN shows individual element of safety argument, the relationships between these elements, that is, how individual requirements are supported by specific claims and how claims are supported by evidence and the assumed context defined for the argument.

To persuade others of the truth of an overall claim, supporting claims are made. Each supporting claim may need further support. Finally, claims should be supported by an evidence. This gives a notation of a tree structure of which the top node is the overall claim. If all claims are proved to be true by evidences, then overall claim is considered to be certified by this document.

GSN uses four core elements: goal, strategy, solution and context [1]. Goal describes a claim. Strategy describes how a goal is decomposed to subgoals that

[1] This definition is based on [14]. The latest version uses two additional elements: assumption and justification [5].

support it. Solution describes an evidence. Context describes a range the claim is valid. In addition, when a goal (or strategy) is left to be undeveloped intentionally, the undeveloped tag is added to the goal (or strategy). These elements are linked to show the sequence of derivation of an overall claim. Note that the existing relationships between elements are all supporting relations, and the structure shows an evidence-based reasoning.

We propose two kinds of notations with respect to a judicial judgement based on the concept of GSN.

3 Structuring Notation for Applying Law

The first notation is for documenting the part of law applications. It is called a *structuring notation for applying law (SNAL).*

3.1 Logical structure of a law

It is considered that a law is generally stated by a general rule and its excetions.

```
G <= B1 & ... & Bn.
exception(G,E1). ... exception(G,Em).
```

It means that if goals $B_1, \ldots, B_n$ are satisfied, then G is satisfied unless exceptions $E_1, \ldots, E_m$ hold [2].

An example of a crime of murder shown in Section 1 is written in a logical formula as follows [3].

```
crime_of_murder <=
   human & action_of_murder & intention_to_murder.
exception(crime_of_murder,legitimate_defense).
```

In an argumentation-based approach, this structure is represented using attack and support relations. For a specific case, if an evidence is approved, then the corresponding argument is satisfied. Figure 1 is a representation in a form of (BAF). In this figure, a simple solid arrow indicates a support relation, and a straight arrow with a cutting edge an attack relation. The leaf nodes correspond to the existence of evidences. 'ex' and 'ab' on the nodes show that there exist approved evidences and not, respectively. Existence of the required evidence supports the argument on its upper node, whereas absence attacks it[4].

The evidences of the first three goals are approved. On the other hand, the evidence for the last one is not. Therefore, legitimate_defense is not proved to be true. Thus, it is judged that the crime_of_murder is effective.

[2] A PROLEG-like syntax is used here. It is the same meaning of the clause `G <-- B1 & ... & Bn & not(G1) & ... & not(Gm)` in Prolog.

[3] It is a simplified version of the real law.

[4] Actually, goals are decomposed into subgoals again before reaching evidential facts.

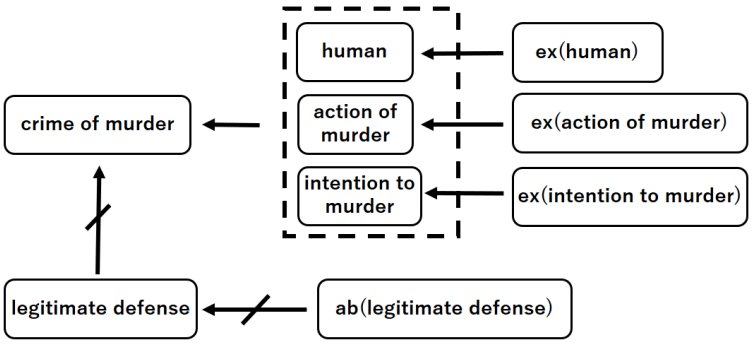

Fig. 1. Representation in a form of BAF.

This form of representation shows the argumentation structure well. However, it is not suitable to understand the grounds and derivation of the conclusion, since the representation includes a counter argument. An argument is false if its counter argument (attacking node) is proved to be true. If counter arguments appear in a nested manner, it is difficult to understand the derivation of the top goal. Although an attack relation seems to be easily represented using a support relation in BAF, a proper semantics should be defined. We rather take an approach to discuss subgoals to satisfy the main goal.

SNAL is basically generated without using an attack relation. An attack relation is written in a form of support relation.

3.2 Overview

SNAL is generated from a law and approved evidential facts. Here, we do not consider how evidential facts are approved (it is discussed in the next section) but assume that the result of approval is given.

There are three kinds of nodes in SNAL: goal, strategy and solution, which are written using the symbols in Figure 2.

Fig. 2. Notation used in SNAL.

Goal is a requirement to be satisfied. Strategy is the corresponding number of civil/penal code. And solution is an approved evidence.

3.3 Generation procedure

Assume that a law has a logical structure stated in the previous subsection.

1. Make a root node corresponding to the required crime.
2. For each goal, repeat the followings as far as possible.
   (a) Make a goal for a required fact.
   (b) Make a strategy corresponding to an article in the law with respect to the goal, and make a link from the goal.
   (c) Make subgoals based on the strategy that are required to satisfy the goal, and make links from the strategy to each subgoal, respectively.
3. Add solution nodes corresponding to the approved evidences to the leaf nodes, and make links from the upper nodes, respectively.

As a result, a tree structure notation is obtained.

Note that each link is a supporting relation: to satisfy the requirement of a goal of the source of the link, all goals of the destination of a link should be satisfied.

The required claim is effective if all leaf nodes are solutions.

3.4 Example

In Figure 3, we illustrate an example of SNAL for the crime of murder.

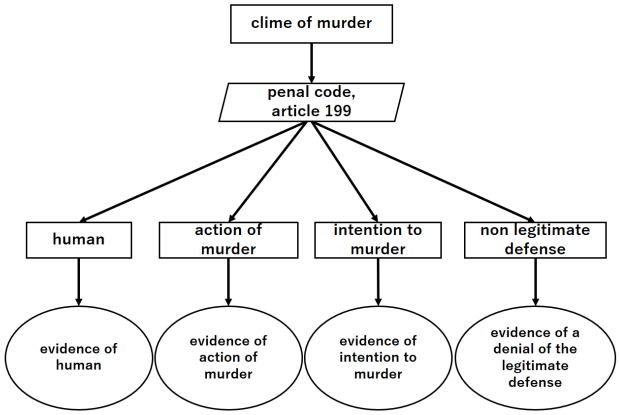

Fig. 3. Example of SNAL.

The purpose is to certify crime_of_murder on the root node is effective. We show this by decomposing the top goal into four subgoals depending on the article 199 in the Japanese penal code. The requirements of these four goals are satisfied by the supports of the solutions. For example, the requirement of

human is satisfied because the evidence of human is approved. Note that the requirement of non_legitimate_defense is satisfied because the evidence of denial_of_the_legitimate_defense is approved. It is represented in a form of support, whereas this relation is represented in attack relation in BAF (Figure 1).

4 Structuring Notation for Fact Finding

The second notation is for documenting the part of fact finding. It is called *structuring notation for fact finding (SNFF)*.

4.1 Fact finding by evidence

In a court, a judge approves the evidences and decides whether the crime is effective, after all evidences both from a plaintiff and from a defendant are presented and all arguments are given.

Fact finding is a process to decide whether the presented evidence can be admitted as a reliable fact.

4.2 Overview

SNFF is generated from a requirement E to be proved and the result of a judgement. First, we classify the aspects on which E should be proved in a hierarchical form, which is called *a template for* E. Next, for the template for E, we add all evidences presented in the judgement sentence.

There are five kinds of nodes in SNFF: goal, strategy, solution, doubt and ignored, which are written using the symbols in Figure 4. The first two are used to create a template and the remaining three are used to show the result of a judgement.

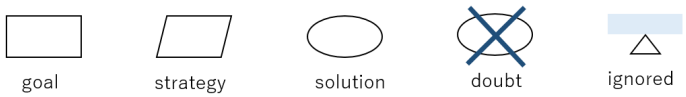

Fig. 4. Notation used in SNFF.

Goal is a requirement to be satisfied. Strategy is the criteria of classification to show the satisfaction of the requirement. Solution is the evidence that is admitted to satisfy the requirement in a designated goal, and doubt is the evidence that is rejected or doubted. Ignored is the goal which is not taken into consideration; and a tag is attached to the goal.

If there exists some criteria of classification, it is adopted as a strategy; otherwise, the classification based on the aspects that a judge, a plaintiff and defendant consider to be necessary is adopted as a strategy.

4.3 Generation procedure

First, we make its template for a requirement E to be proved.

1. Make the root node corresponding to the goal for E.
2. For each goal, repeat the followings as far as possible.
   (a) Make a goal for a required fact.
   (b) Make a strategy corresponding to a criteria of classification with respect to the goal, and make a link from the goal.
   (c) Make subgoals based on the strategy that are required to satisfy the goal, and make links from the strategy to each subgoal, respectively.

As a result, a tree structure notation is obtained.

The leaf nodes of a template are the goals corresponding to the requirements which cannot be divided any more and evidences should be added to.

Next, we add solution nodes and doubt nodes to these leaf nodes of the template and make links from the corresponding nodes, respectively, based on the judgement statement. If there is no presented evidence for some leaf nodes of the template, change the nodes to the ignored nodes by adding the tag of ignorance.

When multiple solutions are added to a single goal, it means that multiple evidences are approved to satisfy the corresponding requirement. When a single solution is added to multiple goals, it means that a single evidence is used to satisfy multiple requirements.

The requirement corresponding to the goal is satisfied if a goal node has no doubt node as its child node. And top goal E is approved if there is no doubt node in the tree.

4.4 Examples

We illustrate an example of SNFF for the crime of murder. Here, we make our SNFF for a fact action_of_murder based on the criteria shown in the book [7].

Creation of a template The requirements to prove action_of_murder are classified into three kinds depending on the temporal aspects: prospectant facts, concomitant facts and retrospectant facts. These classes are again divided into subclasses as follows.

First, we consider the division of concomitant fact. Concomitant fact is divided as follows:

1. chance of the crime of the defendant
2. possibility of existence of a person with a chance of the crime, who is different from the defendant
3. circumstantial basis with respect to the connection between the crime and the defendant (e.g. epidemiological investigation, similarity of methods of the crimes, commonality of the place or time)

4. essential disagreement
5. miscellaneous facts

The first aspect of chance of the crime of the defendant is divided as follows:

1.1. physical existence of the defendant at the time on the scene
1.2. methods of the crime

The fourth aspect of essential disagreement is divided as follows:

4.1. non-established alibi
4.2. probability of the third person's crime
4.3. a victim's self-harm

For the last aspect of miscellaneous facts is divided as follows:

5.1. physical trace left on the scene
5.2. trace left on the victim's body
5.3. trace indicating the special usage of the tool
5.4. items left by the criminal

Next, we consider the decomposition of prospectant fact. Prospectant fact is divided as follows:

1. characters of the defendant and the victim
2. crime performance of the defendant
3. motivation, emotion, desire
4. plan, attempt, intention
5. customs

Finally, we consider the decomposition of retrospectant fact. Retrospectant fact is divided as follows:

1. physical evidences
2. organic and biological evidences
3. mental evidences

For ease of viewing the notation, only hierarchical decomposition of concomitant fact is shown, and those of prospectant fact and retrospectant fact are partly abbreviated; actually, some subgoals of prospectant fact and those of retrospectant fact are divided into subgoals.

Based on this criteria, a template is created (Figure 5). At first, a requirement of action_of_murder is divided into three subgoals based on the temporal aspects. It means that requirement should be proved on these three aspects. These subgoals are again divided into several subgoals respectively, and the requirements should be proved on each aspect. In this way, a template is generated. As for each strategy, classification shown in the book [7] is used. Note that the strategy in this case is a simple classification, but generally it can represent more complicated condition.

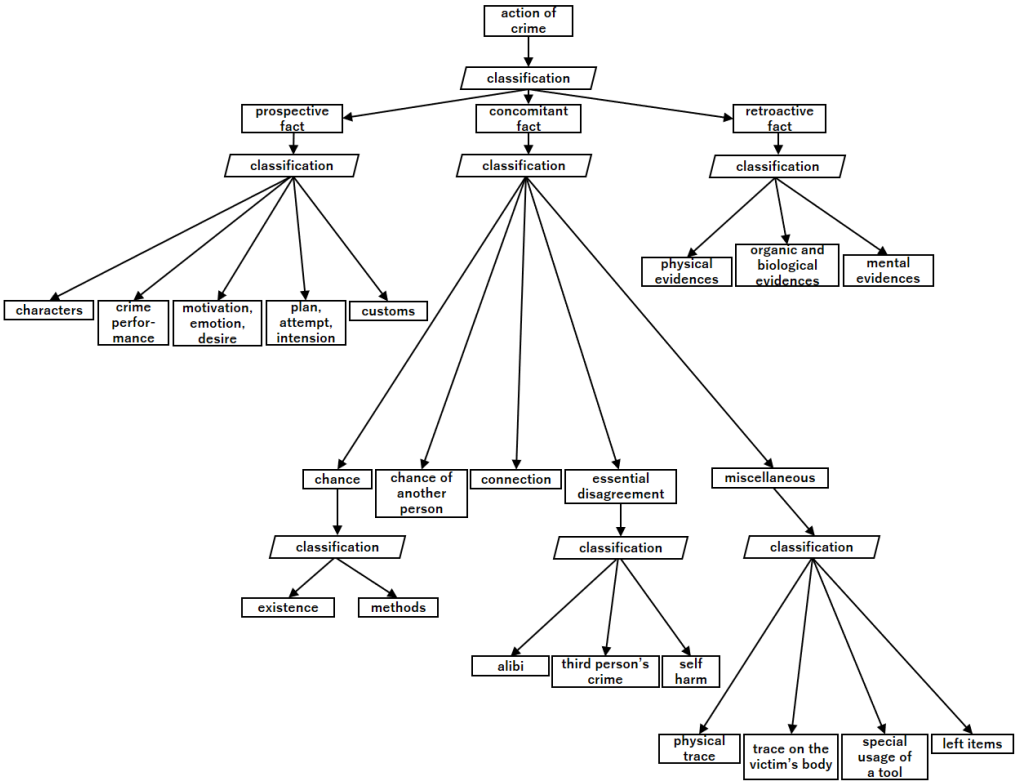

Fig. 5. Example of a template.

Addition of evidences After the completion of the template, evidences are added depending on the judgement sentences.

We show two examples of SNFF.

Figure 6 shows the SNFF for case#23 in [7].

The fact that the defendant is acquainted with the place is presented as an evidence of the crime performance, and the economic plight is presented as an evidence of motivation. And both of them are approved to become grounds of the satisfaction of the requirement of prospectant fact.

Meeting between the victim and the defendant on the previous night before the victim's disappearance is presented as an evidence of physical existence of the defendant at the time on the scene. The document showing the break of the alibi is presented as an evidence of the absence of an established alibi. And it is approved to become grounds of the satisfaction of the requirement of essential disagreement. A rope on the neck is presented as an evidence of items left by the criminal. All of these evidences are approved to become grounds of the satisfaction of the requirement of concomitant fact.

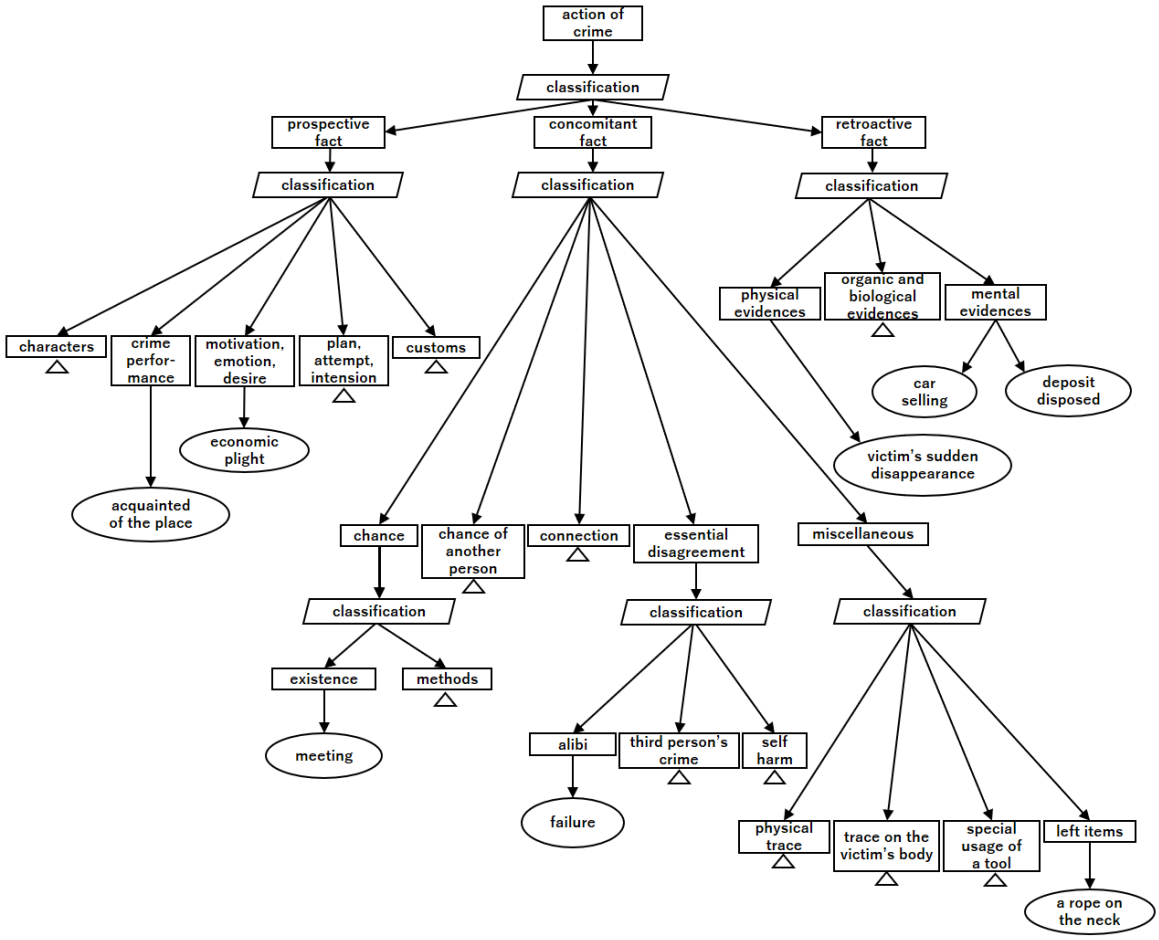

Fig. 6. SNFF for Case#23 in [7].

Sudden disappearance of the victim is presented as a physical evidence. The fact of selling the car by the defendant and disposal of the deposit from the victim are presented as mental evidences. And all of them are approved to become grounds of the satisfaction of the requirement of retrospectant fact.

SNFF shows these structure using supporting relations explicitly. As a result, a fact of action_of_murder is approved, since there is no doubt node.

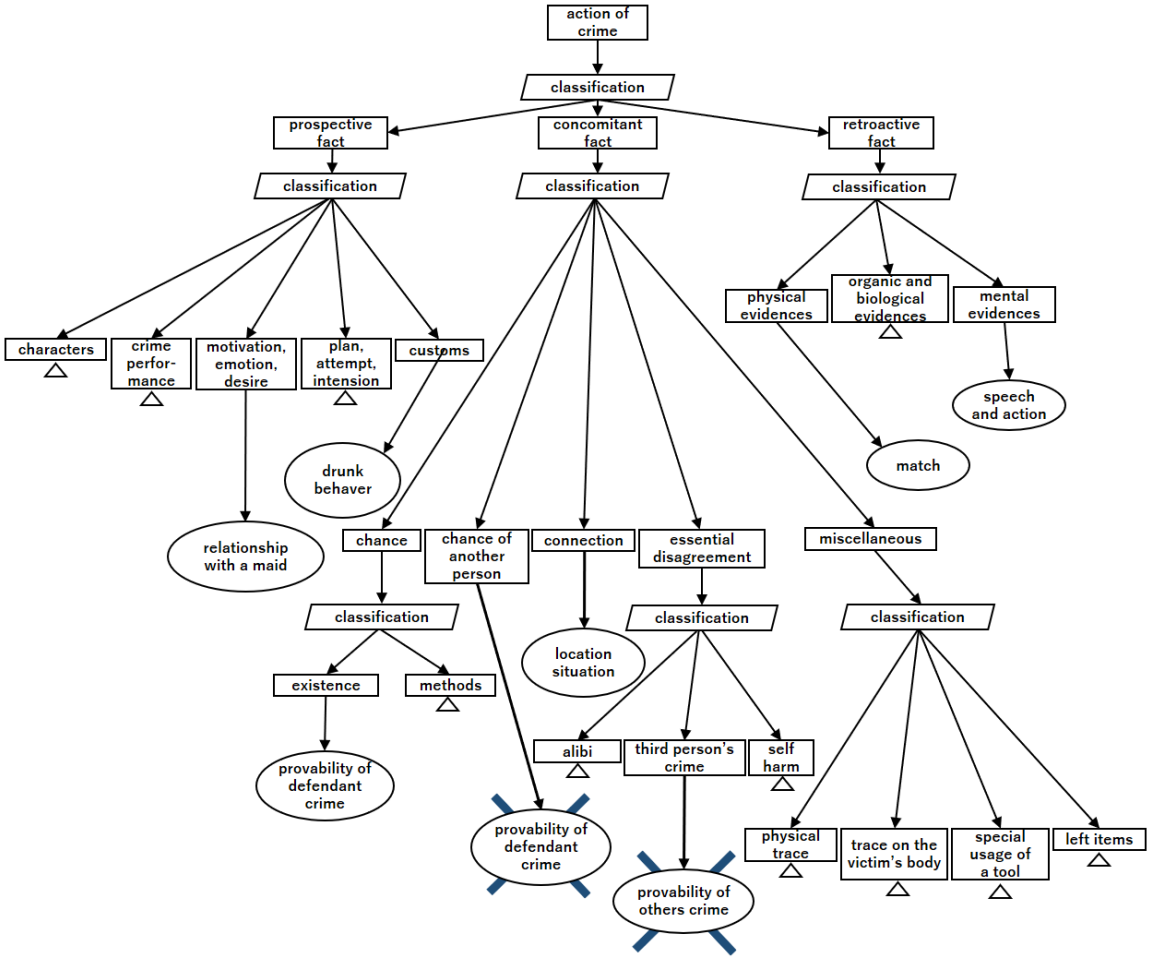

Fig. 7. SNFF for Case#5 in [7].

Figure 7 shows another example. It is the SNFF for case#5 in [7].

In this figure, there are several doubt nodes. Therefore, the requirements of their parent nodes are not approved. Thus, the fact of action_of_murder is not approved. It follows that the crime_of_murder is not applied in this case.

5 Related Works

Several representation methods for argumentation have been proposed and tools have been provided. Carneades [4] is a formal mathematical model of argument structure and evaluation which applies proof standards to determine the defensibility of argument and the acceptability of statements. Argument structure is represented using argument and statement, and their relationships. A Wigmore chart is a graphical method for the analysis of legal evidence in trials [15]. A node denotes each argument, and there are several kinds of nodes: support, denial, explanation and so on. It is useful to show the role of each argument and their relationships at a glance. Wigmore chart may be used in fact finding from circumstantial evidences. As the main propose of these existing methods and tools are analysis of argumentations, arguments and their relationships of *pro* (support) and *con* (attack) are explicitly represented. On the other hand, our aim is to clearly show the logic how the main claim is proved to be true without using attacking claims.

GSN is extended to handle the claims on both side of supporting and attacking the overall claim [12]. In this paper, we create the notations SNAL and SNFF from the plaintiff's viewpoint. Actually, there should be other notations from the defendant's viewpoint which have different structures. It is more interesting if we represent notations from both sides, compare and combine them.

6 Conclusion

In this paper, we have proposed new graphical representations for law application and fact findings. They show an evidence-based reasoning in which derivation from the evidences to the conclusion is clarified without using attack relations. As a template to make SNFF is not always fixed, it can be used to find possible arguments to make a law effective and to structure them through the construction of SNFF.

The proposed method can provide a support for a person who are not familiar with a law to understand the judgement and to be persuaded by the decision. This is a first step for a systematic treatment of judgement statement.

In future, if a number of documents in these structuring notations are accumulated, then it is possible to make a common template.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number JP17H06103.

References

1. Amgoud, L., Cayrol, C., Lagasquie-Schiex, M. C. and Livet, P. On bipolarity in argumentation frameworks. *International Journal of Intelligent Systems*, **23**(10), 1062–1093, (2008).
2. Bench-Capon, T., Prakken H. and Sartor, G.: Argumentation in legal reasoning. *Argumentation in Artificial Intelligence*, 363-382 (2009).
3. Dung, P. M.: On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. *Artificial Intelligence*, 77:321-357 (1995).
4. Gordon, T. F. and Walton, D.: The Carneades argumentation framework, - Using presumptions and exceptions to model critical questions, In *Proc. of COMMA2006*, 195-207 (2006).
5. SCSS The Assurance Case WG: Goal Structuring Notation Community Standard (Version 2). SCSS Publications. 2019.
6. Hitchcock, D. and Verheij, B. (eds.): Arguing on the Toulmin Model. Springer, 2006.
7. Hosokai: Fact Finding from the Viewpoint of Circumstantial Evidences. Hosokai, 1994 (In Japanese).
8. Kawasaki, T., Moriguchi, S. and Takahashi, K.: Transformation from PROLEG to a bipolar argumentation framework. In *Proc. of SAFA2018*, 36-47 (2018).
9. Kelly, T.: Arguing safety: A systematic approach to managing safety cases, D. Phil. Thesis, University of York, 1998.
10. Nair, S., Walkinshaw, N., Kelly, T. and de la Vara, J. L.: An evidential reasoning approach for assessing confidence in safety evidence. In *ISSRE 2015*, 541-552 (2015).
11. Satoh, K. et al.: PROLEG: An implementation of the presupposed ultimate fact theory of Japanese civil code by Prolog technology. In *JSAI-isAI 2010: New Frontiers in Artificial Intelligence*, 153-164 (2010).
12. Takai, T. and Kido, H.: A supplemental notation of GSN aiming for dealing with changes of assurance cases. In *IEEE International symposium on Software Reliability Engineering Workshops, Workshop on Open System Dependability 2014*, 461-466 (2014).
13. Toulmin, S. E.: The Uses of Arguments. Cambridge University Press, 1958.
14. Weaver, R., Despotou, G., Kelly, T. and McDermid, J.: Combining software evidence - arguments and assurance -, *ACM SIGSOFT Software Engineering Notes*, 30(4): 1-7 (2005).
15. Wigmore, J. H.: The Problem of Proof. *Illinois Law Review*, 8(2): 77-103 (2013).
16. Walton, D, Reed, C. and Macagno, F.: Argumentation Schemes, Cambrige University Press, 2008.