An Approach to Expressing and Sharing Value in Collaboratively Producing Creative Knowledge Artifacts

Keiji Hirata(1), Toshihiro Takada(1), Yasunori Harada(1),
Shigemi Aoyagi(1), Yasuhiro Yamamoto(2), Kumiyo Nakakoji(1,2)

(1) NTT Communication Science Laboratories
(2) RCAST, University of Tokyo
2-4, Seikacho Hikaridai, "Keihanna Science City", Kyoto 619-0237 Japan
{hirata,takada,harada,aoyagi}@brl.ntt.co.jp, yxy@computer.org, kumiyo@kid.rcast.u-tokyo.ac.jp

Abstract

The value to each stakeholder involved in collective creation may have a big influence on the resulting knowledge artifacts. Explicitly sharing and debating value will lead to better mutual understanding and more sustainable knowledge work groups. Value, however, is vague, elusive, and difficult to capture. This paper proposes an approach to express and share value using value-aware primitives. Instead of asking participants how much they value a decision or a knowledge artifact, the approach associates value with the variations of the produced knowledge artifact. If one considers two variations of a knowledge artifact equally good, differentiating components between the two variations are assigned the same value. If one thinks a variation is better than another, then a unique component in the former variation is assigned more value than the latter. Once a system obtains a set of declarations by using such value association primitives, the system can provide useful information for the members of a group, for example, identifying the multi-aspect value of a compound object, seeking peers with similar value, and forming a subgroup of people for a particular knowledge task sharing the same value.

1 Introduction

Creativity is inherently collaborative (Fischer, 2003). Through collaboration, small contributions made by individual stakeholders are combined and made substantial because collaboration leverages the unique skills of individuals that mutually complement an individual strength; as a whole these lead to concept restructuring, innovative aspects, and new artifacts (Fischer, Scharff & Ye, 2002). We are interested in supporting collaboration with a variety of people and computational agents, including virtual ones that are not present at that time; examples include him/herself in the past, software agents, as well as real stakeholders who are temporally and geographically remote. This has been considered as an attempt to overcome the time and space barriers (Grudin 1994). It would be significant and valuable to realize such collaboration because being able to access to oneself or a group of people in the past, current or in the future breaks down personal barriers and builds trust, which facilitates and provides social capital. The more a stakeholder is immersed in the influence of stimulating peers and memorable mentors, the more creativity is gained, according to a perspective on creativity that emphasizes a situation in which creativity is embedded in a community of practice with changing standards that requires a social approval process (Csikszentmihalyi & Sawyer, 1995)(Shneiderman, 2000).

The value assessment for each stakeholder involved in collective creation may have a big influence on the resulting knowledge artifacts. Explicitly sharing and debating value will lead to better mutual understanding and more sustainable knowledge work groups consisting of real or virtual stakeholders (Gaver, Dunne & Pacenti, 1999). In particular, we argue that sharing values is equally to or even more important than sharing physical co-presence. Sharing value assessment of each stakeholder plays an important role in making his/her presence and reality strongly felt; since decision making reflects value assessment and is visible to other stakeholders, sharing value assessment is achieved by observing others' decision makings. The entire decision making process form a personality, and the perception of such a consistent personality reinforces our belief in his/her presence and reality. For example, if we have rich email communications with a member of a group, the communications convince us that the person exists even if we have not actually met him/her face-to-face. In another example, consider an augmented service in which

a stakeholder can examine an artifact by playing back its production process. Since the stakeholder learns how a creator built the artifact and what a creator was thinking during production time, the stakeholder can directly understand the creator's consistent intentions, idea development, and value assessment. As a result, the stakeholder can easily recognize what components are common with and distinct from the creator's value assessment, even if the creator himself/herself did not appear on such a video.

Our premise is that sharing values will make us believe in the presence and reality of remote collaborators more than being co-present in the real world. The above Email and playback examples support the premise, and our approach will open another dimension of augmented presence and reality. The stored email and recorded artifact production process in the above examples can be regarded in some sense as externalizations of value assessment that is tacit, elusive, and subjective. Externalization simplifies sharing value assessment among stakeholders and hence facilitates creative collaboration. We call such collaboration "value-aware artifact-mediated collaboration." Creativity has multiple aspects; first, it is deeply concerned with personal subjectivism and aesthetics; second, it means that an individual stakeholder expresses concepts, intentions, and values when producing artifacts. Since the first aspect is beyond the scope of our present research, our focus is on the second.

We argue that the approach of the existing CSCW studies can be considered as prosthesis. Much conventional research on collaboration environments has assumed that real world face-to-face communication is the best possible model for collaborative settings regarding it as the most desirable form of collaboration. The approaches assume that the face-to-face physical co-presence is where individual members of a group can most strongly "feel" the presence of the other members. The aim of such conventional research is therefore set to reproduce communication in an electronic collaborative environment as similar to the actual world. Electronic collaboration environments, such as teleconferencing systems and online virtual spaces, often try to provide an individual stakeholder with functionality that compensates the missing capabilities for a real face-to-face environment. For example, they include eye-gaze awareness and Hi-Fi audio-visual services.

Our aim is to augment the collaboration capability of an individual stakeholder to communicate with others who are remote to lead to a new collaboration experience. For such a purpose, we have decided to study value shared by communicating stakeholders within a community developed over time: in particular, externalizing and formalizing values and how people share values.

This paper proposes an approach to express and share value using value-aware primitives. Instead of asking each participant how much a stakeholder values a decision or particular knowledge artifact, the approach associate value with variations of a knowledge artifact he/she produces. The paper is organized as follows. In Section 2, we introduce and examine observable value-aware primitives in an ordinary artifact production process. In Section 3, we formally describe value-aware primitives, which make it possible to formally handle value. In Section 4, sample applications and future work are shown. Finally, in Section 5, we briefly conclude with our expectations and perspective.

2 Value-aware Primitives

There is a view that the process of creating a knowledge artifact is merely an accumulation of small transformations and modifications (Kolodner, 1993). Each operation in transformation and modification may contribute to the creativity of the resulting artifact. How and what operations are performed during the process of creating a knowledge artifact must reflect a creator's intention in transition, trial and error, and decisions about value. The operations include merger, segmentation, substitution, selection, imitation, interpolation/extrapolation, emphasis, quotation, abstraction, and style transformation. The usage of the operations is viewed as the externalization of value assessment.

2.1 Substitution Operation

If a creator thinks two variations of a knowledge artifact are equally good, differentiating components between them are assigned the same value. If he/she thinks one variation is better than the other, then a unique component in the

former variation is assigned more value than the latter. Now, we focus on the substitution operation, since substitution is basic and frequently used when creating a knowledge artifact. By substitution, we refer to an operation that replaces a part or a component of an entire artifact with something else. The resulting artifact may be superior, inferior, or equal, depending on what part is substituted for what.

As an example of substitution in creating an artifact, suppose that one wants to cook a beef stir-fry dish with a vegetable; alternatives, green beans and broccoli, are considered green beans are chosen. He/she makes and eats beef with green beans, but does not like it so much. So, in the next dish, he/she substitutes broccoli for green beans, and makes beef with broccoli, which he/she loves. The substitution of green beans with broccoli has increased his/her value of the beef stir-fry dish.

Another example of substitution is concerned with making a private playlist, which originally referred to a list of musical selections for radio broadcast or concert performance; the term playlist recently can be used for personal use on a PC media player as well. Suppose that someone wants to make a three-song playlist to listen to during short commutes. He/she has decided that the first song is "Amazing Grace" by Aretha Franklin and the third is "Confirmation" by Charlie Parker, but he/she has not decided the second song yet. The first time, he/she inserts "Breathe again" by Babyface as the second song, but does not feel these three songs fit comfortably. Then, he/she tries to substitute the second with "Besame Mucho" by The Beatles and is finally satisfied. In his/her three-song playlist, he/she shows favor to the latter playlist that includes the Beatles song.

The last example of substitution regards a drawing. A child combines such geometric figures such as a line, a circle, and a square to draw a human. Suppose that the child has drawn the figure on the left shown in Figure 1.

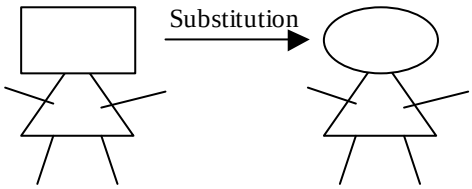

Figure 1. Example of Substitution in a Drawing

Then, it occurs to the child that an oval expresses a human face better than a square. The child substitutes the square with the oval as on the right; the child has given a higher preference to a human figure with an oval face.

2.2 High-level Operations and Meta-Statements

As such, by merely observing the substitution operations, we can capture the creator's intention in transition, trial and error, and decisions on value, related to a part or the whole of a knowledge artifact being created. Since substitution is, however, a low-level operation, we cannot always identify the precise meaning of substitution performed: the relationships invoked either of the-same-as, more-than-the-other, or not-equal-to. For example, sometimes substitution fails to improve the entire whole impression of a playlist, and there are occasions in that a person cannot judge which is better before or after substitution.

Since only substitution is insufficient, we must focus on a higher-level operation *selection* because selection apparently reflects creator's intention. Next, based on the selection operation, we believe that even higher-level operations, such as *imitation* and *interpolation/extrapolation*, embody the creator's ideas. Furthermore, a creator sometimes faces a situation in practice where he/she cannot judge whether an operation should be performed or where he/she is uncertain how to apply an operation. To correctly represent the situation, we introduce meta-statements, *commit* and *delay*. Commit means that a creator decides to execute an operation, and delay means that a creator cannot do so at that time, and hence he/she suspends execution until a decision is made. Delaying the execution of an operation and exploring alternative operations to be executed corresponds to parallel paths (Terry, Mynatt, Nakakoji & Yamamoto, 2004).

We identify an aggregation of individual small decisions on value with an entire value assessment. If for all the components of an artifact, a creator thinks they are more significant than others, it normally follows that the creator

thinks the entire artifact is more significant than another. When an anomaly, however, is discovered, for example, the entire artifact is less significant under the same conditions, that anomaly can be a salient feature of the creator's sense of value. For example, a creator is uncertain whether to execute substitution, yet later the creator executes substitution. This is normal, but if the events occur in the inverse order, an anomaly appears. Also this observation can be a salient feature of the creator's sense of value.

2.3 Features

The above operations, substitution, selection, imitation, interpolation/extrapolation, and meta-statements, commit, and delay have the following features:

- The operations are quite familiar to us and are frequently used in ordinary situations. They naturally express a stakeholder's intention in transition, trial and error, and decisions on value. Therefore, they do not impose an extra burden on a stakeholder in creating an artifact.

- The operations have high descriptive power. In substitution, a part can be substituted for another of any other category; there are no stipulations that the part substituted should belong to the same category. For example, wine can be substituted for bread and a CD for a book. Therefore, substitution associates the values of two artifacts of two distinct categories with each other; it resembles barter.

- The operations are tractable in terms of formalization. They externalize value assessment of a stakeholder and can be straightforwardly modeled as the following procedural relationships: the-same-as, more-than-the-other, and not-equal-to. A resulting operational semantics of value assessment could be suitable for symbolic inference (Carbone, Nielsen & Sassone, 2004). Our approach differs from an economics approach. Economics has intensively studied value (money) for a long time (Jones, 1976); everything is uniformly converted into cost, and each value or price is calculated in a single metric. The economics approach to value can be viewed as global and statistical (Mas-Colell, Whinston & Green, 1995).

3 Formalization

We denote $\kappa[x]$ as knowledge artifact κ, including a component x that may be substituted for another.

3.1 Substitution and Selection Operations

Suppose that a creator wants to substitute x for another component y to improve the value of the entire artifact. Here we introduce a new notation for performing substitution and selection (Figure 2):

$$\kappa[x] \subseteq \kappa[y] .$$

Here substitution and selection can be regarded as a single operation. By observing that a substitution result $\kappa[z]$ is undesirable and is dismissed, no description is obtained from the observation.

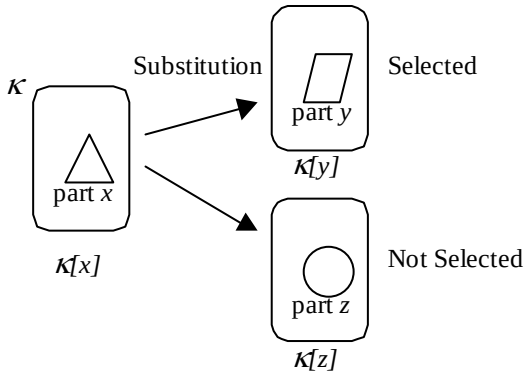

Figure 2. Substitution and Selection Operations.

As shown in the cooking example, we write

stir-fry-dish-of-beef[green-beans] ⊆ *stir-fry-dish-of-beef[broccoli]*

to express a situation where he/she makes another beef stir-fry dish by substituting broccoli with green beans, which is more delicious to him/her. Similarly, for the playlist and line drawing examples, we write

three-song-playlist["Breathe again"] ⊆ *three-song-playlist["Besame Mucho"]*

line-drawing-human[square-face] ⊆ *line-drawing-human[oval-face]* .

Besides ⊆ (more-than-the-other), we think of the other relations, the-same-as and not-equal-to, denoted as = and ≠, respectively. However, substitution is too low-level to precisely distinguish these relations from the others. Instead, we focus on the higher-level operations below.

3.2 Imitation and Interpolation/extrapolation Operations

Among the above operations, we consider the imitation and interpolation/extrapolation operations. Suppose that someone wants to make artifact *κ[x]* imitate masterpiece *κ'*. He/she substitutes *y* for *x* and successfully obtains result *κ[y]*, which is more similar to *κ'* than *κ[x]* in a similarity measure (Figure 3).

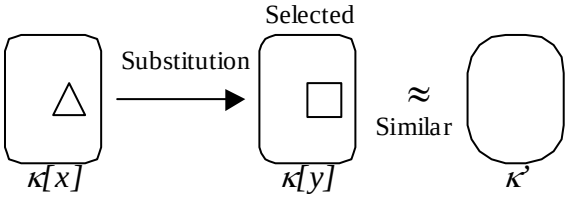

Figure 3. Imitation Operation.

Then we acquire the following relations:

κ[x] ⊆ *κ'*

κ[x] ⊆ *κ[y]* .

The first formula means that masterpiece *κ'* is more valuable than the starting artifact *κ[x]*. The second means that the substitution operation increases the value of artifact *κ* because *κ[y]* imitates *κ'* more than *κ[x]*.

Suppose that someone wants to create an artifact between *κ1[a,b]* and *κ2[c,d]* that is an interpolation of the two and that *κ1[a,b]* and *κ2[c,d]* are similar to each other to some extent in a similarity measure. He/she substitutes *b* for *d* and *c* for *a* and successfully obtains result *κ3[a,d]* which is more favorable than *κ1[a,b]* and *κ2[c,d]* (Figure 4).

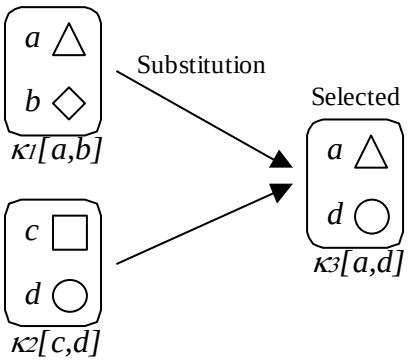

Figure 4. Interpolation/Extrapolation Operations.

Then we acquire the following relations:

$\kappa_1[a,b] \subseteq \kappa_3[a,d]$

$\kappa_2[c,d] \subseteq \kappa_3[a,d]$.

The first formula means that the artifact after substitution is more valuable than before, and the second formula means the same.

3.3 Commit and Delay Statements

When trying to execute an operation in situation σ at time *t*, we face two cases: one is that a creator can decide to execute operation $\kappa[x]\ rel\ \kappa'[y]$ (commit), and the other is that a creator cannot and delays executing operation $\kappa[x]\ o\ \kappa'[y]$ (delay), as mentioned before. We denote the two cases borrowing situation theory's notation (Barwise & Perry, 1983):

Commit: $\sigma \models_t \kappa[x]\ rel\ \kappa'[y]$

Delay: $\sigma \models_t \kappa[x]\ o\ \kappa'[y]$,

where "*rel*" is either of relations, $\subseteq$, =, and $\neq$. In contrast, "*o*" means an undefined relation that will be instantiated later. It is important to distinguish situations where a creator has decided either of $\subseteq$, =, and $\neq$ from those where he/she cannot, since being unable to decide which is better is also important information in value assessment.

4 Applications and Future Work

Once a system obtains a set of formulae using such value-aware primitives, it can provide useful information for the stakeholders of a group, for example, identifying multi-aspect value of a compound object, seeking peers with similar value, and forming a subgroup of stakeholders for a particular knowledge task sharing the same value. We show the applications of value-aware primitives that we plan to implement in the future.

4.1 Inference on Value

We can derive several useful consequences from a set of meta-statements $\sigma \models_t \kappa[x]\ rel\ \kappa'[y]$ and $\sigma \models_t \kappa[x]\ o\ \kappa'[y]$ as follows:

- Suppose that the value of $\kappa[x]$ is known and that $\kappa \approx \kappa'$ (κ and κ' are similar to each other in a similarity measure) are given, where the similarity measure is defined somewhere else. Then, we can infer the value of $\kappa'[x]$,. For example, suppose that someone likes coffee with milk, denoted as *coffee[milk]*. If we obtain meta-statements including *coffee[milk]*, a system can infer the value of *tea[milk]* by supposing that *tea* is similar to *coffee*.
- We have three types of relationships: those for value (the-same-as, more-than-the-other, and not-equal-to), those between knowledge artifacts based on similarity and structure, and those for time. If for a compound object, we acquire the values of the object and its components, we can identify the value of the compound object in multi-aspect corresponding to the three types.

- A bowl of rice topped with beef is denoted as *rice-bowl[beef]*, a bowl of rice topped with chicken and egg *rice-bowl[chicken-and-egg]*, and a bowl of eel on rice *rice-bowl[eel]*. When we acquire meta-statements from a community regarding the three rice bowls, we can infer which is more similar to *rice-bowl[beef]* for the community, *rice-bowl[chicken-and-egg]* or *rice-bowl[eel]*. Since value relations between artifacts are partial order, the domain of artifacts makes a lattice structure.

Such problem setting is almost the same as case-based reasoning (Kolodner, 1993). However, we are interested in the acquisition of tacit value assessment from the performed primitives that are superficial and the logical inferences on a domain in which mathematical orders between components are defined. Thus, our research could theoretically underlie case-based reasoning.

As for inference rules on value, it is natural to assume transitivity and if $\kappa[x] \subseteq \kappa'[y] \wedge \kappa'[y] \subseteq \kappa[x] \rightarrow \kappa[x] = \kappa'[y]$. In an initial stage, a small number of meta-statements do not produce much meaningful information (so-called the cold-start problem). To improve the initial stage performance of inference, it is possible to obtain information about the value assessment of an individual stakeholder through questionnaires.

4.2 Communityware

Also for communities or groups of stakeholders, we can think of ways of inferring useful information: community similarity based on an aggregation of an individual value assessment, social cohesion in a certain measure, a community boundary, and interpersonal/impersonal trust. Furthermore, we can provide stakeholders with useful social network services: seeking peers with similar value assessment and forming a subgroup of stakeholders for a particular knowledge task that shares the same value assessment.

Naturally, stakeholders in a community trade various knowledge artifacts for creative collaboration, such as barter. We believe that trade is an interesting activity occurring in creative collaboration, since trading activities straightforwardly reflect value assessment and force stakeholders to unite as a community for creative collaboration. We can explore the mechanism, structure, and semantics of value assessment in creative collaboration through trading activities in a symbolic logic approach.

4.3 Paint Software

We can implement paint software, employing value-aware primitives (substitution, selection, imitation, interpolation/extrapolation, and the statements, commit, delay, and so on). It is important to consider how to effectively use the value assessment information acquired from the paint software for facilitating creative painting collaboration.

5 Concluding Remarks

Instead of increasing awareness and developing high fidelity of reality within a conventional virtual collaboration setup, our approach is to build ontology so that people can more easily share value assessment for creativity. We started our project to externalize and share value assessment of an individual stakeholder by collaboratively producing creative knowledge artifacts. The aim of the project was to realize an augmented CSCW room for creative life using various media (Hirata et al., 2004). We are implementing several tools and systems to demonstrate the advantages of our approach and to evaluate in detail how and what influences augmented presence and reality have on the value assessment acquired by value-aware primitives. We hope that the tools and systems make it easier to control and predict the behaviors of an individual stakeholder and a community for creative collaboration and the production of knowledge artifacts.

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