Visualization of Synchronous Collaborative Modeling Activities

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Abstract

This paper presents Synergo, a new collaboration support environment that monitors the activity and permits visualization of various quantitative parameters, like density of interaction, symmetry of the activity, degree of collaboration etc, particularly useful for understanding the mechanics of collaboration. Synergo has been proposed as a testbed for analysis of small-group model-building synchronous interaction.

1. Introduction

Synergo is a new collaboration support environment created using the *Abstract Collaborative Applications Building Framework*, on which other modeling environments like ModelsCreator and ModellingSpace [1], have been based. Synergo architecture shares many common characteristics with them, like high replication in client nodes, a peer-to-peer XML-based interaction protocol, a shared activity space and a chat tool. The innovative aspect of Synergo is its advanced tools for collaboration analysis and visualization.

The main activity space of the Synergo modelling environment is shared by multiple actors, permitting collaborative problem solving. Synergo has been used for synchronous building of flow charts, concept maps, and other semantic modeling activities by small groups of students, both for collocated groups of students in a class [3], and in distant groups, like in the case of students of a distance learning course [4].

An important feature of Synergo relates to analysis and evaluation of collaboration activities. So a set of Analysis and Visualization tools are included to be used by teachers and researchers. The tools can reproduce the modelling activity, using the created logfile, in a step-by-step or continuous way. This is complementary to an activity annotation functionality and to the visualization of activity indices like the density of interaction, symmetry of interaction, degree of collaboration etc., as discussed in section 3.

2. Modelling Collaboration

Modelling activity is usually considered as a process of refinement of abstract ideas ("abstract objects") and externalisation of these ideas in the process of model building and exploration. Capturing of this process is done through the following activity model. *Event actions* are the key concept of this model. These are either changes of the state of the activity space or communication messages.

This model of the activity comprises the following four dimensions: (i) The *time*, (ii) the *actors*: $A=\{A_1, A_2, ..., A_k\}$, (iii) the *objects*: $O=\{O_1, O_2, ..., O_\ell\}$, which refers to constituent parts of the model, rejected model components or abstract concepts, and (iv) the *typology of events*. The latter is a dimension through which interpretation of the activity can take place. We assume that there is an existing analytical framework, which defines this typology $T=\{T_1, T_2, ..., T_r\}$. In OCAF [2] we have included such a closed set *T*, however, the activity model may be considered as independent of a specific analytical framework.

Using the above four dimensions we can describe any given activity as a sequence of discrete non-trivial action events produced by the actors. $E=\{E_1, E_2, ..., E_m\}$. Each event is defined as a tuple $E_{i_{tAOT}}=(t_i, A_i, [O_i], [T_i])_i$ where $i \in [1, m]$, *t* the event timestamp, *A* the actor of the specific event, *O* an optional parameter referring to the object of the specific operation and *T* an optional parameter which interprets the event according to the typology T.

Synergo adheres to a typology of generated events, thus automating the categorization of recorded events, As a result annotation of the model, as well as a number of visual views related to density and symmetry of events of a particular type can be produced automatically.

However there are events, like exchanged dialogue messages, that cannot be automatically categorized. In this case a tool is provided for annotation of these events, as shown in fig.1.

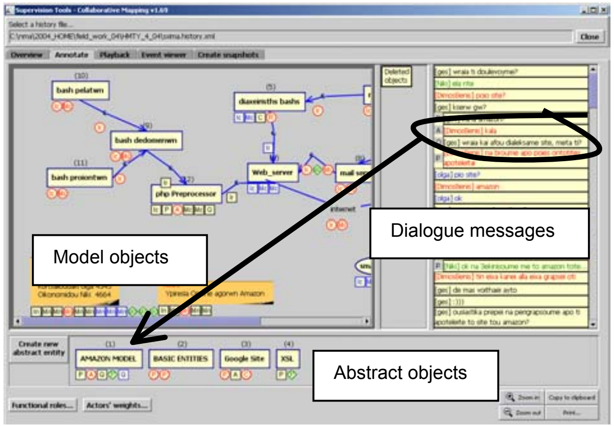

Figure 1. Annotation of dialogue events

In fig.1 the produced model during collaborative activity is shown, as made of various objects (concepts and links of a concept map). Also abstract objects, like the notion of the "*Amazon Model"* that have been discussed during the activity appear. A dialogue event relating to such an object is shown in fig.1 (*Ges:"what to assign to the Amazon site?"*), This results in a categorization of the dialogue event, as a *Q* (Query) and its association to the related object.

3. Visualization of the activity

Using the model of activity described above, a number of indices can be defined and accordingly presented in a visual form. For instance, if we assume that N events of Actor A concern object O, then the contribution of Actor A to object O is measured as $AC_{AO} = W(A) \cdot \sum_{i=1}^{N} W(T_i)$ where *W(A)* is the relative weight of actor A και $W(T_i)$ is the weight of type T_i of event i, that contributed to generation of O.

The history factor *HF* of *O*, is defined as $HF_O = 1 - \frac{stdev(AC)}{M\sqrt{k}}$, where $HF \in [0,1]$ and *M* is the mean value of the AC for object O. HF takes value around 1 when there is symmetrical contribution of all actors in the history of object O and around 0 when the object has been discussed and used by small part of the group.

The collaboration factor of object O is defined subsequently, as $CF_O = HF_O \cdot W_O \cdot \frac{L(OE_O)}{m}$, $CF_O \in [0,1]$

Where W_o the relative weight of object O in the model, $L(OE_O)$ is the length of action events of object O and *m* the total number of action events in E. Finally the collaboration factor of the modeling activity CF is defined as the mean value of all components' collaboration factors, including the abstract objects, or objects that were discussed and later rejected: $CF = \frac{\sum_{i=1}^{\ell} CF_{O_i}}{\ell}$, $CF \in [0,1]$

This parameter, in addition to other indices like the density of activity of specific type of action events per time unit, can produce views of the activity that can lead to understanding of the collaboration dynamics.

In figure 2 an example of such visualizations is shown: (a) an extract of the annotated solution, (b) the evolution of CF during the activity, (c) density of actions of chat messages and insertion of new object in the model, (d) a visual representation of members contribution in the activity of a 4-member group.

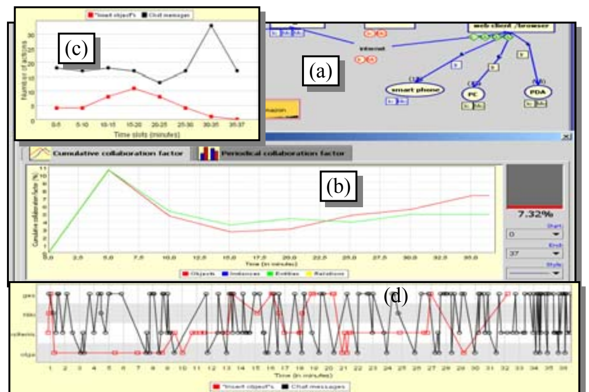

Figure 2. Activity visualization

4. Conclusions

The visualizations produced by Synergo are useful for posteriori analysis of modeling activities. Some of them like (c) and (d) in fig.2 are automatically generated, while (a) and (b) are the result of annotation process discussed here. We are currently investigating the impact of these representations in on-line activities support, as meta-cognitive tools.

5. References

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