Analysing Face to Face Computer-mediated Interactions

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Abstract. Detailed analysis of face to face computer mediated interactions implies a study of a corpus composed of the interaction traces produced by the collaborative tool and video and audio recordings. Because of their separate nature, it is frequently difficult to perform this joint analysis. We examine the needs of researchers, the particular difficulties they face and the state of the art in tools assisting analysis. We describe how to facilitate a number of analysis methodologies by simplifying situations where entities are multiple: several researchers (inter-coder reliability), several sources for the corpus (multi-modal interactions) or several analyses (for re-use of prior analyses or for the confrontation and comparison of two different analyses. We believe that capitalizing on previous analyses and affording parallel analysis of video and computer-mediated traces will open new avenues for researchers and teachers.

Introduction

We are interested in analysing face to face situations where students are learning with the aid of computer-based collaboration and communication tools. Detailed analysis of such interactions implies a study of a corpus composed of the interaction traces produced by the collaborative tools and video and audio recordings. Because of their separate nature, it is frequently difficult to perform this joint analysis. In this paper, we describe the particular difficulties of analysing face to face computer-mediated interactions; we also present various existing tools for assisting analysis of similar data in order. We show how the core functionalities of replaying, finding and annotating can be combined in a new tool called Tatiana (Trace Analysis Tool for interaction analysts). Furthermore, different analyses of the same corpus might frequently be enhanced by cross-comparison - a task that is very difficult when researchers are not able to work in close collaboration. Given the inherent cost of setting up a study, it would be good to be able to reify an analysis, allowing subsequent research on the same corpus while taking prior analyses into consideration.

Difficulties involved in analysing face to face computer-mediated situations

Face to face computer-mediated interactions combine three types of interactions, each of which presents their own analysis challenges. Consequently, analysing these interactions compounds these difficulties.

The supporting medium for analysis of face to face interactions is frequently audio-video recordings and transcriptions of these recordings. The nature of such recordings is to make sense only when being "replayed"; this results in a very high time-cost for the analyst. This may be one of the reasons for making a transcription. A transcription, however, is semantically limited compared to the video source as it only contains certain aspects of the interaction. In cases of an exploratory form of analysis, the transcription is performed "blind", as the focus of analysis is not yet known. The analysis will therefore necessarily be a back and forth between the transcription and the recording, leading to the last difficulty: synchronising the two analysis supports.

Human-computer interactions can be recorded through logging of user actions. A "transcription", of a certain nature, is thus already available. The challenge lies in understanding this transcription, which is often presented in a very "technological" format. A further difficulty comes from the granularity of logging: what level of detail is necessary? If

this level is very small, how does the researcher grasp the larger picture? This problem is compounded by the fact that anything that is not recorded is lost and that these choices cannot always be made at the time of the recording but must frequently be made during the design of the computer software.

An alternative method of recording human-computer interactions is through screen-capture. This solves the problem of what to record as everything is recorded. The problems are then identical to those of audio-video recordings, namely that transcription and analysis are time-costly operations.

Computer-mediated human interactions carry their own share of problems. They can either be considered as two (or more) human-computer interactions which happen to be partially shared or as a human interaction which happens to be mediated by computer. In the first case, two (or more) recordings (either through logging or screen-capture) can be combined. The problem then becomes that of duplicate data: the shared data is redundant and the additionnal data is often of marginal interest or distorts the analyst's perception of the interaction (because it is seen from one participant's point of view). In the second case, only "interactive" actions (which affect all participants) are recorded, most often as a computer log on the server.

Lastly, as is frequently the case with introducing cameras into classrooms, particularly in cases of group work, there are difficulties in terms of number of cameras, difficulties in understanding audio recording in a noisy environment, etc.

All these factors combine to make analysing face to face computer mediated interactions à particular challenge. There are at least two data sources of different natures (video and computer logs) which need to be synchronised and combined. Methodologies then need to be found which coherently deal with such heterogenous data. In summary, the problems lie in managing the data (collection, synchronisation, etc.), understanding the data (again requiring synchronisation, replaying, understanding of the computer logs) and transforming the data into some kind of homogeneous form to which a coherent analysis methodology can be applied.

State of the art

By examining four existing tools which assist interaction analysis we will attempt to show their strong points in order to determine functionalities which are of use for a researcher.

ColAT (Avouris et al., 2007) is a tool for assisting analysis of computer-mediated interactions where the data is both in video format and that of a common format of logfile (Kahrimanis et al., 2006). This data is synchronised by means of a remote control widget which plays the video and simultaneously selects the corresponding lines in the logfile, displayed as row-data (cf. fig. 1.). Conversely, selecting a line in the logfile automatically positions the video at the correct point. The trace (or logfile) can be filtered in order to restric the view to certain participants, events or tools. These elements can also be collected on three subsequent levels, based on activity theory (Bertelsen et Bodker, 2003). ColAT provides a series of tools allowing coding, annotation, visualisation and statistical analysis.

Replayer (Morrison et al., 2006) is a tool for coordinating video recordings and visualisations of numerical data such as histograms, temporal graphs and superpositions of geographical data on maps. Replay works with a database and a server, allowing researchers to work together and to synchronise several visualisations on multiple computers (cf. fig. 2).

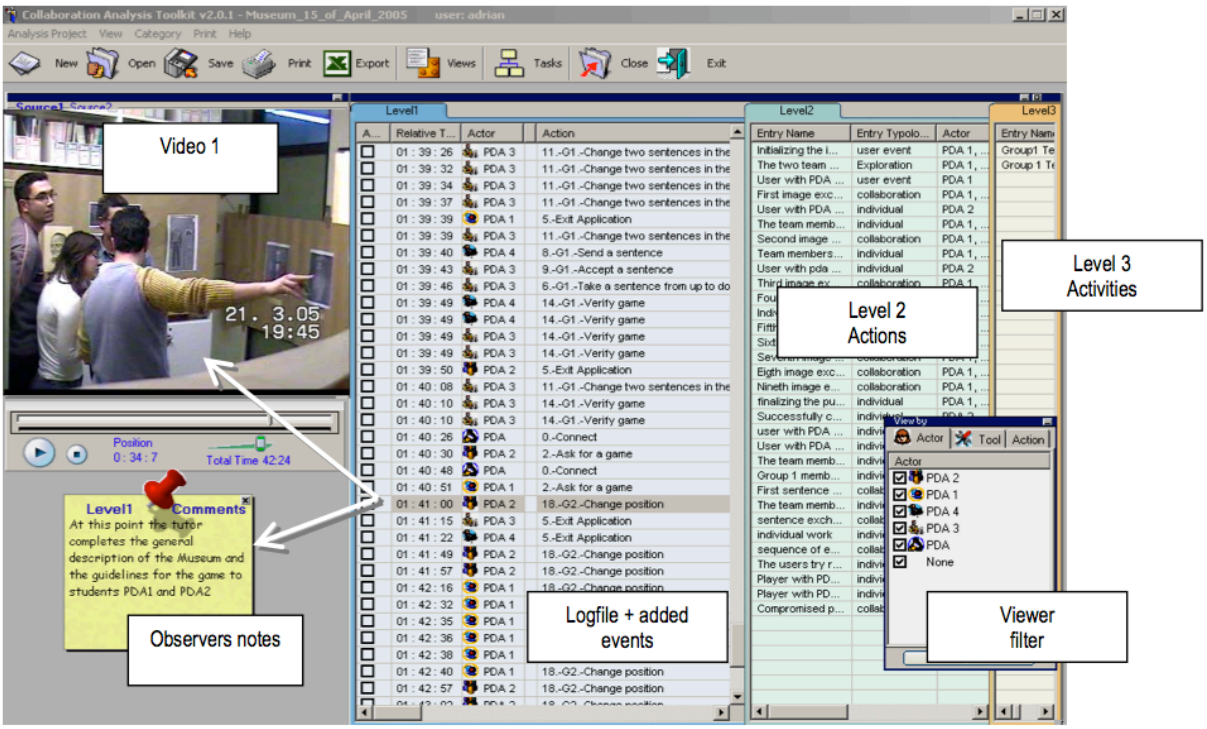

Figure 1 • The ColAT window (Avouris et al. 2007) p. 18.

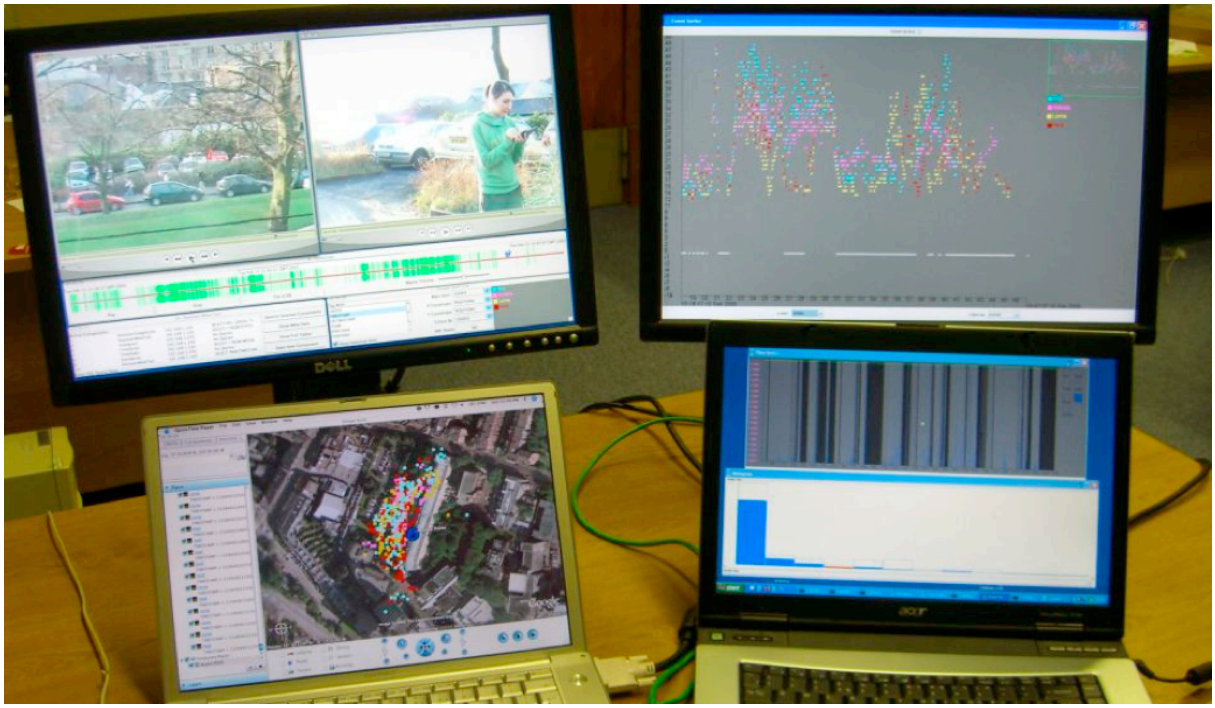
Figure 2 • Replayer launched on two computers, each with an extra screen (Morrison et al. 2006) p. 10.

Replayer is based on a system of independent plugins allowing for a wide variety of visualisations which can all be synchronised with the video. Analysis is currently limited to attaching free text to a time duration.

2.1.3. Abstract trace analysis tool

The Abstract trace analysis tool (Georgeon et al., 2006) affords visualisation of a trace (in this case data from automobile driving) in a symbolic graphical manner (cf fig. 3). Each symbol

matches a type of event (sampling of speed, steering wheel angle, pilot's gaze) and reveals additional information when it is selected.

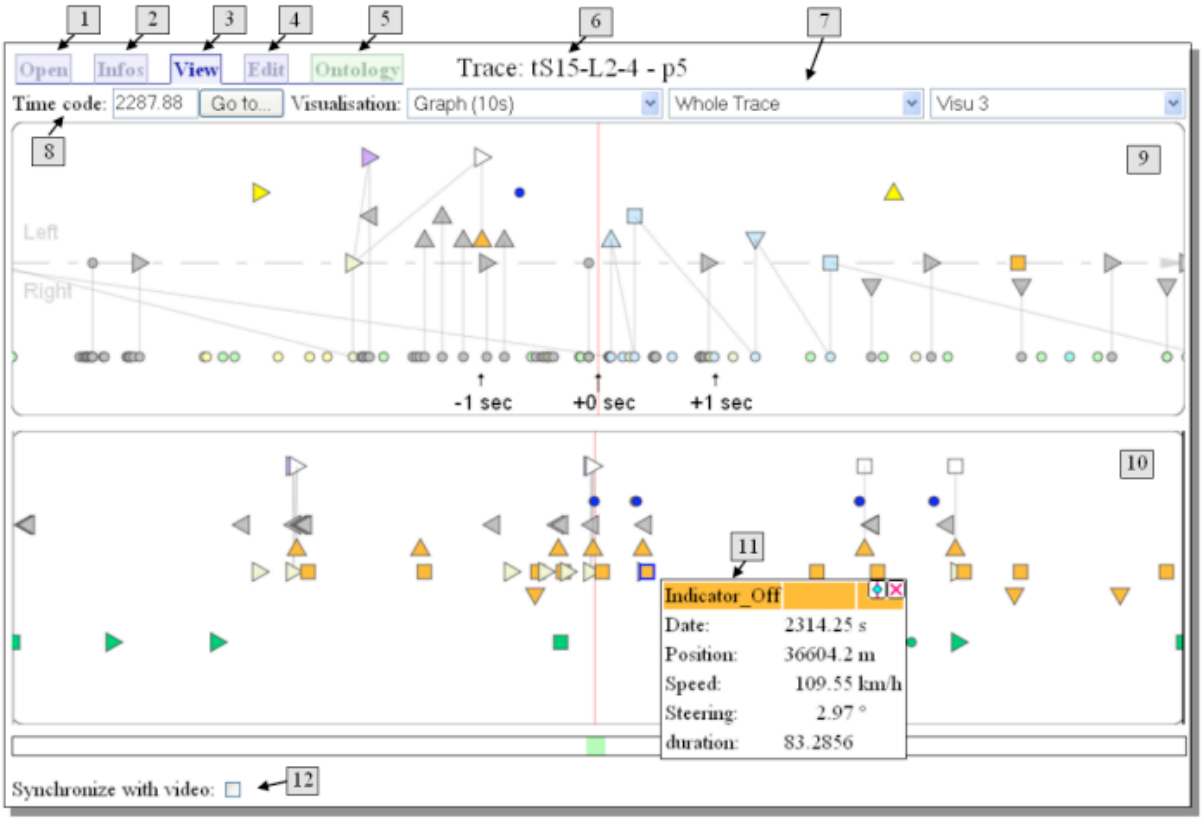

Figure 3 • Abstract (Georgeon et al., 2007)

Because these elements are presented in too much detail, Abstract allows for the creation of transformation rules to create higher-level symbols (braking, accelerating, lane changing, etc.). These transformations can be combined as many times as necessary, simplifying the task of identifying significative sequences in the trace. Abstract also provides a mechanism to synchronize de visualisation with a video.

DREW (Corbel et al., 2002), (Corbel et al., 2003) is an example among others (Digalo (Lotan-Kochan, 2006)) of software which can read its own traces and reproduce on screen that which was displayed during the recording (cf. fig. 4). This is an attempt to avoid screen captures and their disadvantages while still affording the researcher the means to understand the logfiles in an easier fashion.

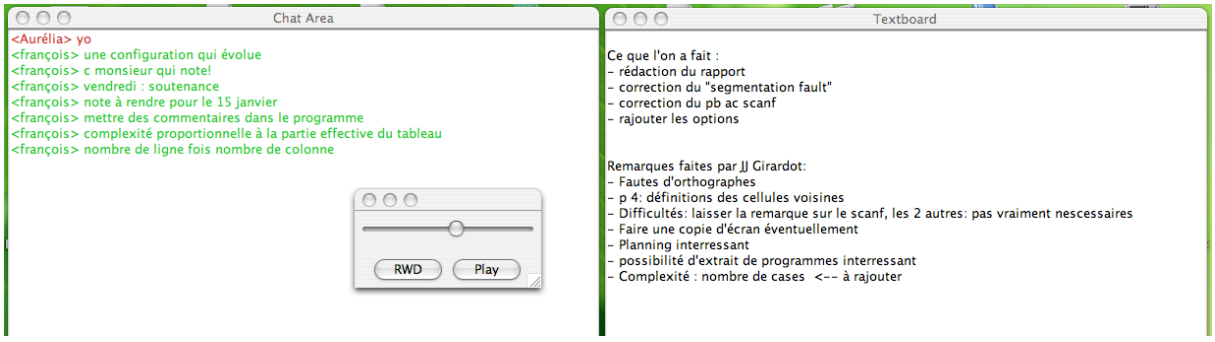

Figure 4 • The DREW replayer

Because the DREW replayer completely recreates the system's internal state when replaying, this visualisation is not limited to what was present on screen at the time of the recording. The analyst could, for instance, examine what was "out of sight", by moving the scrollbar. The DREW replayer can also give additional indications. For example, DREW's shared text editor does not differentiate between various author's contributions. However, the replayer can show each element of the text in a colour associated with it's author (not implemented in fig. 4).

In summary, these four tools are designed for researchers desiring to analyse computer-mediated interactions and, except for DREW, are specifically geared towards multiple data sources (typically video and computer logs). The following capabilities seem to be important.

All four tools are able to to replay what happened in real time, with synchronisation of the various data sources. It is interesting to note the use of *brush and link* (Becker et Cleveland, 1987) where selecting an element in one view (e.g. a row in ColAT) selects the same *time* period in all the other views ("going there" in the video and highlighting that time in visualisations). For researcher interested in interactions, context is often key: video is not a media which affords parallel viewing of what happened immediately before or after an event. In this, we see the usefulness of visualisations with a time axis and of the presentation of logfile data.

Rewriting, in various forms seems to be a useful feature: coding, transcribing, grouping to reduce granularity and visualisations. It should be noted that these rewritings are rarely destined to replace their source, but rather to complement it. In ColAT, rewriting is limited to three levels only, but ABSTRACT provides for as many rewrites as needed.

Finally, the DREW replayer contains an interesting idea. By scarifying exact reproduction of what happened on screen, it is possible to have an "augmented" reproduction. In this way, private spaces, for instance (such as the area for preparing a message in the chat before publication) could be combined into a single view, provided this information was traced, rather than opening in parallel several screen capture recordings.

Tatiana – a trace analysis tool for interaction analysts

Tatiana is composed of three functionalities. A **navigator**, a **replayer** and an **annotator**. These functionalities attempt to answer three basic analysis needs: the navigator allows the researcher to find interesting elements of the corpus, the replayer allows the researcher to understand what happened and the annotator helps the researcher to perform the actual analysis his or her corpus through annotatation, categorization, coding, sequencing, transcribing, etc.

The navigator works by allowing filtering, finding and combining of various sources of data, computer traces in particular. The challenge is to find ways to help researchers sift through numerous hours of data in order to find sections of interest for closer analysis and to present the results in context. We are also interested in overall views which give a large picture of an interaction, in order, again, to identify interesting sections. This leads to the methodological quesition: what is interesting? Clearly, a computer can not identify such sequences, but it can maybe show the data to researchers in such a way to facilitate such insight.

The replayer functionality synchronizes the various data sources and aims to take the computer log files and reinsert them into the tool that created them thus showing what

happened on screen simultaneously with videos, audio and data in « row format » (an excel view of a log file for example). This functionality aims to help bridge the gap between having the data of an experiment and being there in the flesh to observe. By not using screen capture to recreate what appeared on the screen, we are able to even further bridge the gap towards comprehension of what happened by integrating more information into the replayer interface, such as awareness data or private spaces which are purposely left out of the "normal" user interface. Not only are the data sources synchronized, but a "brush and link" pattern is applied to everything including additional analysis data such as annotations and transcriptions, allowing hopping from one data source to another to provide a different view of the same instant cf fig. 5.

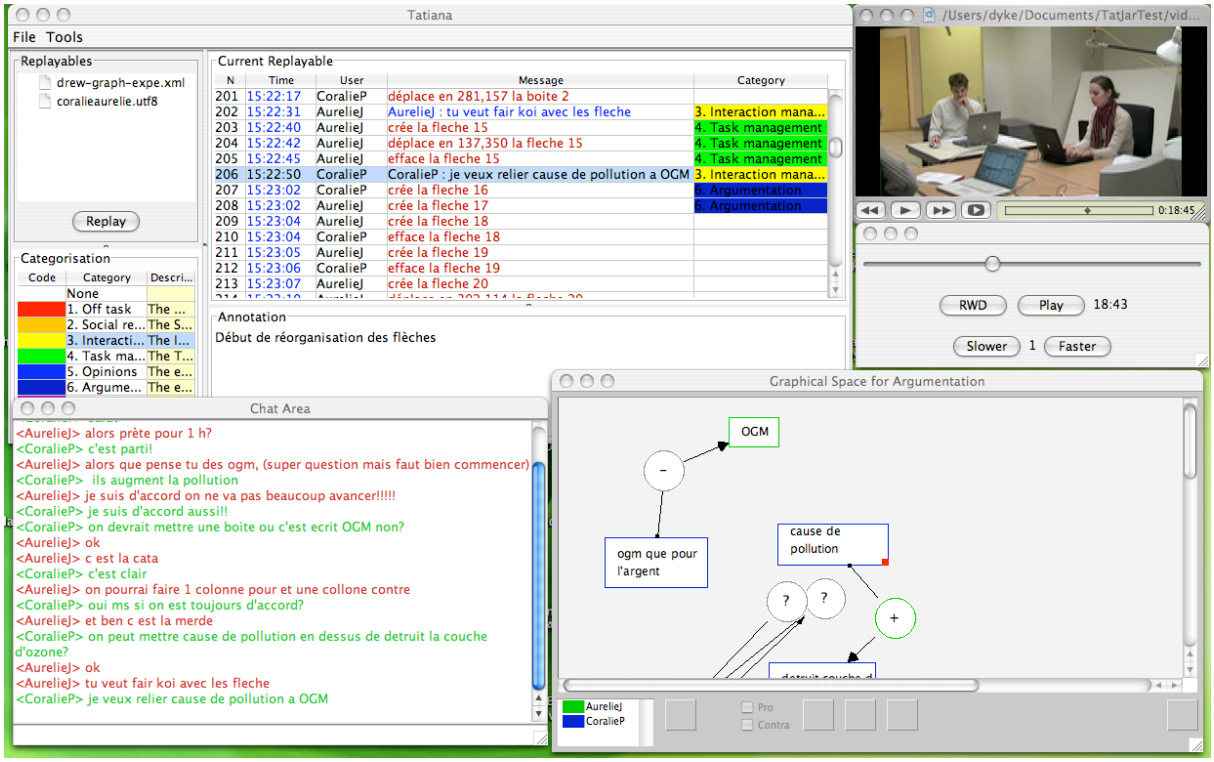

Figure 5 • Tatiana

The annotator currently allows coding and free-form annotation. Other functionalities such as transcription, segmenation and grouping together of events will be added when we have a greater understanding of their use. We are also attempting to address certain research methodologies, for example by providing built-in support for inter-coder reliability.

Team work and analysis reification

In order to maximise the potential for team work and to allow easy sharing of analyses, we are working on modelising the analysis process and its result. The key to enabling reification of analyses is to separate the different entities. An analysis then becomes the association of a corpus, an analysis methodology and the researcher who applies it to the corpus. We are currently describing models both for representing corpora and analysis methodologies, using transformation of documents of the primary corpus to obtain new documents and the creation of links between concepts and parts of the corpus to describe an analysis. This simplifies situations where entities are multiple: several researchers (inter-coder reliability), several sources for the corpus (multi-modal interactions) or several analyses (for re-use of prior analyses or for the confrontation and comparison of two different analyses). We are currently applying this model to describe the RAINBOW methodology (Baker et al., 2002): The model

defines a list of categories; the act of coding consists of creating a link between a category and a certain zone of the corpus (Corbel, Girardot & Lund, 2006). We also explore the case of analysing "re-formulation", by looking at how concepts appear in different forms in different media, such as dialogue, computer-based chat and a co-constructed text.

Conclusion

Face to face computer-mediated collaborative learning may be one of the most challenging forms of interaction to analyse. By identifying the functionalities of existing tools and the needs of researchers, we have shown how we designed a tool specifically focused on these kinds on interactions.Although it is clear that corpora are gathered in order to answer a particular research question, it is still interesting to capitalise upon analyses that have already been carried out. The situation is not so different in the case where any of the three entities (researcher, analysis methodology, corpus) we have presented are multiple - again we see the necessity of simplifying the task of the researcher so that complex analysis methodologies are not disregarded due to their prohibitive cost (whether it be cognitive, economical or time-related). We believe that capitalizing on previous analyses and affording parallel analysis of video and computer-mediated traces will open new avenues for researchers and teachers alike.

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