

# 17      **Grounding "subjective views"** **Situation awareness and** **co-reference in distance learning**

Paolo COTTONE, Giuseppe MANTOVANI

**Abstract.** In high-level learning contexts learners are not viewed as the passive receivers of huge amounts of information, but as social actors capable of making meaning of changing and ambiguous situations. Learning involves collaborative social processes intended to stimulate the meaning-making capabilities of learners; successful collaboration requires that learners share awareness and (some) meaning of the situations they have to face. Distance learning (DL) systems usually give learners little support to stimulate production of shared meaning because creation of a "common ground" among participants to an interactive environment depends on co-reference, which in computer-mediated communication (CMC) environments is often hindered by the fact that context is presented in inadequate ways. Significant efforts have been accomplished to enhance the situation awareness of participants to CMC environments. One level of awareness consists in being informed of the presence, positions and actions of other people in the virtual space. Specific tools - workspace widgets - have been created for this purpose. A further level of awareness is offered by Collaborative Virtual Environments, which allow participants the experience of embodiment. Using avatars, participants can develop "subjective views" of the virtual space and respond to the presence of other avatars. An element of the situation awareness which until now has received little attention is the *cultural framework* that is essential to structure space as a social scenario for people's action. Every community produces a cultural framework to co-ordinate its members' actions and give appropriate meaning to situations. Social norms and everyday routines, which gracefully and tacitly shape people's everyday environments, should be inscribed in the "virtual" *spaces* to make them social *places* inhabited by "real" communities of learners.

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## 17.1 "Information-based" and "meaning-based" distance learning

Computer technologies present limitations in recreating important characteristics of face-to-face communication, especially as far as the pragmatic and meta-communicative aspects are concerned [1]. In this paper we will consider how these limitations can affect distance learning (DL) and the ways in which they could be overcome. We consider two main models of DL, information-based and meaning based [2]. The former's aim is to convey information on the learner's computer screen. According to this model, information is the raw material of learning: learners are supposed to manipulate information according to their needs – for example doing a chemical experiment, filing data from the lesson, responding to the instructor or to colleagues. In information-based DL system usually a pre-packaged instruction is offered in the form of structured video-conferences or software programs, more or less open to possible interventions on the part of the learners, and more or less tuned to the learner's expectations. An information-based system is acceptable when: a – uni-directional communication (flowing from the teacher to the learners) is suitable to the context (that is, is appropriate to face the peculiar problems addressed by the system); b – the pre-packaged information communicated to the learners is relevant to the educative aims which the program proposes; c – the information transmitted by the system is easy to manage without ambiguities on the learner's part. The model based on transfer of information is in fact satisfactorily applicable only to those forms of learning in which the processes of negotiation of ongoing content can be neglected, pre-packaged information meets the learner's needs, and no significant problem of interpretation of the information given is expected. The pro of the information-based systems is that they are immune from the effects of physical distance.

The meaning-based systems present characteristics opposite to those of the information-based systems. They do not consider problem setting as given but as require that it is constructed by learners. As a consequence, the choice of information which is relevant to the problem solving depends on the learners' decisions in building their problem setting.

There are not general-purpose data to be transferred from one place to another, in this perspective. On the contrary, meaning-based systems assume that every situation has specific characteristics [3], that problem setting is a social construction [4], that choice among different problem settings is a strategic move [5], that what is relevant in a given situation is contingent on both environmental affordances and actors' interests [6], that plans and courses of action depend on specific circumstances [7], and that expertise is essentially embodied in practice [8]. The meaning-based systems hold that "meaning" is a construction set in a precise social and cultural context [9], and they challenge the conception of knowledge as something that can be sent, like a postal package from one place to another [10]. Dobrin [11] claims that knowledge can not be reduced to information; for the information-based model of communication, he writes, "a body of information, of objective facts, is just lying there waiting to be communicated. When the communication is successful, the receiver is put in possession of those facts. The facts determine the communication, unless the originator interferes. The job of the originator is to move the facts from one place to another, handling them as little as possible, so as not to tarnish them" (p. 60).

The meaning-based systems are suitable for supporting the highest level of learning processes. In these, learners are not trained to produce the "right" responses (that is, responses which the teacher or the system consider correct "in general", outside of any specific problem space) but are encouraged to view problems in original ways, to recognize novel configuration of problems when they find them, and to create intellectual instruments to cope with the situations they meet. Meaning-based systems are sensitive to distance because they require intense cooperation between learners [12, 13], a cooperation

that is not easily realized in the workspaces created by computer technologies. Olson and Olson [14], studying synchronous interactions within groups involved in long term projects, found that "maximally collocated" groups, in which individuals met each other frequently in shared physical spaces (typically a *conference room*), had less problems in building "common ground" [15] than "remote teams", in which individuals worked at a physical distance and could communicate only via computer or telephone.

## 17.2 Common ground, indexicality, co-reference in the virtual space

Evidence from field studies [16-18] shows that physical distance can play an important role in limiting the effectiveness of communication and negotiation of meaning [19, 20], which is necessary when new knowledge has to be acquired [21]. Research on new media has stressed the importance of *visibility* and *audibility* (the possibility for the individuals to mutually see and hear themselves, and therefore to gather in appropriate ways the relevant contextual cues relative to the situation in which the communication is being carried out), and of *simultaneity* and *sequentiality* (which refer to the availability of symmetrical communication between the person who sends and the person who receives the messages, and the possibility of conversational turns). Various attempts have been made to increase people's reciprocal knowledge at a distance [22-24] - for example using a digital video camera that was controlled by users, and permitted to observe the same scene from different points of view in order to give participants the impression of "being there" [25] - but the sense of co-presence necessary to the development of a fluid communication is still a problem in distance communication.

One origin of the problem is in the fact that it is difficult to produce "common ground" [26] at a distance. In order to communicate in an effective way, individuals need to share - and to be aware of sharing - a body of knowledge and practices referring to the situation in which they are immersed. In everyday life the creation of a "common ground" is the result of both previous reciprocal knowledge between participants to communication and success in producing new significant knowledge through the ongoing communicative acts.

The "common ground" is not made of a body of general principles which could be incorporated in information-based DL systems but is formed by highly contextual knowledge in which the individuals negotiate and share the sense [27] that they tentatively attribute to the situations they are facing.

Meaning is not something which is completely within the mind, but originates in relation to a context: a word, a phrase, a gesture make sense in the context in which they are produced. If we do not know the context, we cannot say what meaning a word or action has. Duranti [28] produces for example a statement taken from a video recording used in one of his studies: " *'but are you taking this with you?'* In order to understand what the speaker is talking about, one must have direct access to what the pronoun 'this' is referring to: 'it' could concern a bag, a bottle, a guitar, or a person - in that case the expression would take on a derogatory character. The meaning of a phrase of this type cannot be decoded simply by referring back to information, which the speakers have in their minds concerning the meaning of the various words, their reciprocal classification, their intonation etc.. There is a part of the meaning which exists outside of the mind, within the physical and cultural context, in which the speakers find themselves interacting" [29].

This characteristic of language - that of depending on the context for its meaning - is called indexicality because it is based on signs which have an index function [30-32].

Indexicality is not limited to certain words or expressions as those mentioned above, but concerns a great many types of communication. If a commander of an airplane says to his co-pilot during the check of the airliner before take-off, "did you check the gage?" no one,

not even the co-pilot, can know what the commander is referring to, unless the item is being indicated to by gestures, by the direction of the gaze, by the body orientation or by its place in the check list [33]. The commander intends to call the co-pilot's attention to a particular aspect of the environment and to a particular possible interaction between actor (co-pilot) and the environment (cockpit); the success of the communicative act depends on the fact that the co-pilot is able to explore the context to identify with certainty what the commander is referring to.

Also frequently used expressions like "we", "they", "you" etc. require a context in order to be used in non-ambiguous ways. The expression "you must not do it" is not understandable if the context to which it refers is not clear. Even in the simplest situation, in which two people are speaking face-to-face, the referent of the "you" is not to be taken for granted: it could be a rhetorical "you", or the "you" of an interior dialogue to which the other person present is invited to assist; it could be a "you" referred to a third person, who is physically absent, and so on. In a study of Zucchermaglio [33] on work groups collaborating through e-mail, the word "we" referred - in the various contexts in which it was used - to different groups. On some occasions it designated the people involved in the e-conversation at that moment, on other occasions it referred to the two software experts who had to prepare a certain job for the commissioning company, sometimes it meant the four people responsible for the project (two software experts and two engineers from the company who commissioned the work), or firm to which the two software experts belonged. The "we" acquired meaning in the context of the discourse in which it was evoked: if one said "we are not able to respect the software delivery deadline", in this context "we" indicated the two person who had to deliver the software, the two software experts.

### **17.3 Making sense of ambiguous situations: layers of situation awareness**

How is it possible in electronic environments to guarantee the presence of those indexical functions of discourse that in everyday situations contribute to establishing co-reference?

How can reciprocal co-presence of the participants in their respective intentional worlds be achieved? If the forming of a "common ground" within a community of learners depends in a decisive way on the capacity of that community to construct (at least partially) shared meanings for the ongoing situations, and if in turn the meaning of words, gestures, and actions depends on the possibility to refer them to their context, then the destiny of the highest forms of DL depends on the possibility of producing co-reference within the virtual space with a degree of efficacy near to that which can be achieved in everyday situations.

The situations that people face in everyday life are not conglomerates of factual data, to be photographed and to be brought to the knowledge of the social participants in such a way that they are put in possession of common ground. The common ground which constitutes the starting point for an effective communication is not an objective reconstruction of a supposed "state of affairs", but rather the crossroads of diversified perspectives that different actors have on their situations. Everyday situations are unstable and changeable, not only as a consequence of "external" events but especially because the participants, who are part of the situations, and modify them moment by moment with their actions, are different, changeable and incoherent [34]. Situations are not only changing and varied (in the sense that they offer different opportunities for diverse representations by the observer), but are also essentially ambiguous (they can be represented and described in many different ways).

Let us imagine that we have to give an "objective" account of a discussion between co-workers, or of the development of a social event, or of an argument during a company meeting: it would be difficult to produce a reconstruction of the events shared by all the participants - especially in cases in which the participants have different interests [35])

The recognition of this fact allows us to gather the strategic, multiple and multi-layered nature of the social context in which human action is carried out. The meaning of the action enters as an integral part of the definition of the situation, and the contextual elements in turn attribute meaning to the action: "to realize that one cannot just produce a common information space, that it does not automatically appear as the result of developing a common dictionary of terms and objects, as the meaning of these terms and objects must still be determined locally and temporally" (p. 28) [36]. Situation awareness does not consist therefore of a collection of "objective" *information* relative to "how things are" in the environment, but rather it consists of multiple situated scenarios [2, 3, 7, 8] shaped by meanings which participants attribute to the current situation. Situation awareness is not a general picture of what is "really" going on in the environment, but rather a multi-layered, multi-focal way to *shape, to manipulate, to narrate* interests and actions of the actors involved.

We can recognize different layers of situation awareness, from the most superficial which gives us information about the participants to the environment, to the deeper one, which introduces a plurality of perspectives on the virtual space. We have a first layer of situation awareness, which limits itself to monitoring the various environmental zones; tools such as workspace widgets have been designed to support this first layer of situation awareness. Then we have a second layer of situation awareness, which manages the environment not as something external to actors but rather as a space in which the participant is immersed. This is the level of the Collaborative Virtual Environments (CVEs), which aims at providing participants with "subjective views on shared worlds" (Benford et al., 2001, p. 83) [37]. Both the "subjective views" as well as the "shared worlds" rely, just to exist as socially recognizable entities, on the presence of a pre-existing network of cultural norms, which makes actors' actions and intentions communicable and socially significant.

#### **17.4 The first layer of situation awareness: workspace widgets**

In many distance learning systems, users are invited to use a shared workspace, a space in which participants can interact; an example of this sort of environment is the shared electronic whiteboard. The limitations of these systems lie mainly in the lack of tools to support effective WYSIWIS (What You See Is What I See) [38]. WYSIWIS systems should provide participants with information about the space in which other participants are moving, so that a user can know in every moment where other users are and what the focus of their attention is. The information provided by WYSIWIS systems is generally of a graphic type, and is integrated into the system automatically, without distracting the attention of the participants. The effectiveness of these tools diminishes with increase in the shared space visible to each user, and with increase in the complexity of actions permitted to participants by the system.

Recently Gutwin and Greenberg [39] proposed a theoretical framework and a set of tools intended to enhance situation awareness in distance learning systems, thus overcoming the WYSIWIS reference frame in favor of a more ambitious WYSIWID (*What You See Is What I Do*). The framework has three fundamental parts: elements of knowledge, process of maintaining awareness, and uses of workspace awareness. The first part of the framework analyzes the workspace, identifying what type of information the

users in the shared space are exchanging. The second part regards the information obtained from the first part, and indicates in which way the information must be presented to the users. The third part consists of a process, which helps the designers to understand the situations by means of an analysis of the collaborative tasks, and of the interactions developing in the groupware.

On the basis of this framework Gutwin and Roseman [38] have developed and tested several *awareness widgets*. In their study, a software editor to manipulate the layout of newspaper pages (permitting users to move pictures, titles and columns of text) was analyzed. Three awareness widgets were developed. The first is a *multi-user scrollbar*, through which it is possible to know at each moment on which part of the page the various users are interacting. The second, called *radar view*, consists of a reproduction in miniature of the entire page, in which rectangles representing the visual fields of the various users are visible. The third, *local view*, shows in real size the portion of the page immediately adjacent to the cursor of the mouse of each user. Starting from the analysis of the use of the *awareness widgets*, it is possible to know the different types of activity carried out by the users. These tools can be used both to draw information on the material state of the page and to open a communication channel among users. *Local view* is also used as an indexical tool: by means of the movement of the mouse the users can produce gestures to support verbal communication.

Greenberg and Gutwin [40] identified three kinds of information necessary for situation awareness: information about identity, about placement and about the actions undertaken by the users. In order to provide this information they developed various awareness widgets:

- *semantic cursors* for relative position; they attach themselves to the underlying object; multiple cursors are usually considered essential for groupware, for they support indexical reference among participants;
- *one-dimensional radar view* which shows where other people are located within a miniaturized global view; as text is normally formatted to fit within a screen on the horizontal axis, each person's viewpoint needs only show its vertical location;
- *the standard radar views*; they are miniatures of a large shared workspace which show (as different colored boxes) the viewpoint in which other participants are working and the workspace objects which are being manipulated.
- *the portrait radar view* which gives images of participants to an action so that a participant can easily identify other people working there;
- *the head-up radar* which offers as two layers the detailed view and overview of an image: a person works on the foreground, while the miniature appears in the background;
- *the WYSIWID (What You See Is What I Do) view* which shows a full-size, but limited, region around another person's mouse cursor; this widget can reveal fine details of another person's actions.

The widgets support a dynamic mapping of the system, which offers some indication to define the context in which the other co-workers are. Tools such as widgets aim to capture the spatial layout (where participants are and who the participants are) and the operations (what a participant is apparently doing) more than the dynamic interaction which can take place among participants. In spite of the variety of the awareness widgets introduced, *the system does not provide cues to understand the intentions of the other participants*.

## 17.5 Monitoring operations: the widgets in DL systems

Other *awareness widgets* were developed by Wang and Chee [41], who introduced four *awareness widgets* (*status indicator*, *radar view*, *telepointer*, and *object chat*) in a DL system using a shared whiteboard. The collaborative tasks permitted were of two types: the first consisted of participating to a discussion in a group, the second in building a newsletter. The first task is of great interest for the design of a DL system because it consists of an assignment in which there are not predefined correct responses, and the result depends on the success of the interaction among participants. To provide mutual awareness in the collaborative environment, the authors used three different tools: Microsoft NetMeeting, NCSA Habanero and GroupKit. The *awareness widgets* were implemented in these tools on the basis of previous analysis of information most needed by users to acquire knowledge both of the environment and of the actions of the other users.

*Status indicator* is useful in those situations in which the user tries to manipulate an object used by another user; by means of this tool it is possible to know which objects are used by other participants. *Radar view* visualizes a miniature reproduction of the work environment which indicates (through rectangles of different colors) the points of view of the other users. *Telepointer* consists of a sort of cursor that is utilized by the user to highlight a portion of the work area to the others participants, calling their attention to a particular object. *Object chat* is used to facilitate communication through use of indexical reference; it makes "talk" the objects which receive comments from the participants; the tool is similar to a normal chat, but - before writing their comments - participants can select the object to which the comment refers, and the comment appears near the object when this is touched by other participants.

Another interesting application of widgets to DL can be found in the work of Ayala and Yano [42] who use the widgets to develop and maintain situation awareness in a networked community of practice. The learning environment is GRACILE, (GRAMMAR Collaborative Intelligent Learning Environment), a DL system designed to teach Japanese to foreign university students. The system requires, depending on its learning model, the collaborative construction of a text. The structure of the learner model consists of four aspects: learner's capabilities, learner's commitments, learning goals, and learner's group-based knowledge. Using information drawn from the learner model, the GRACILE system supports awareness by allowing communication of learner's intentions, commitments, and capacities. The group-based knowledge is inferred from the analysis of this information and from its dissemination among other participants.

The system makes use of awareness widgets of the textual type: all the information necessary to assist the learner model is visualized in a window. The information is not ordered according to any hierarchical arrangement, or to a peculiar spatial logic. It is important to note that the information provided by participants about their capabilities is the origin of the limitations imposed by the system on the actions that participants can achieve. The limitations of the system are due to the choice to delegate to automatic tools highly critical tasks such as that of deciding what information is necessary for the users.

On the one hand, the automatic procedure does not favor the clarity of the system, on the other it is inadequate to manage complex interactions like those that take place in a DL meaning-based environment. The introduction of the widgets in DL system provides a functional map of the workspace, but does not permit the development of a rich situation awareness including information about goals and intentions of other participants.

## 17.6 The second layer of situation awareness: avatars and "subjective views"

A deeper level of situation awareness can be reached through use, in 3D or in immersion, of avatars in a virtual environment. According to Benford et al. [37], CVEs provide participants with "subjective views on shared worlds" (p. 83) which can support construction of a "common ground": "the technology of Cooperative Virtual Environments (CVEs) aims to transform today's computer networks into navigable and populated 3D spaces that support collaborative work and social play. CVEs are virtual worlds shared by participants across a computer network. Participants are provided with graphical embodiments called avatars that convey their identity, presence, location, and activities to others. They are able to use these avatars to interact with the contents of the world and to communicate with one another using different media, including audio, video, graphical gestures, and text" (p. 79). CVEs are at present closer to enter the market than they were some years ago: they have advantages such as permitting access to many participants and at the same time allowing them a great range of possible manipulations.

Benford and collaborators have developed an impressive body of research in order to build environments which allow plausible simulation of important aspects of human social conduct. They created avatars capable of selecting environmental aspects that they are interested in, and of directing their attention to them. In particular they developed, within systems planned for a large number of participants (MASSIVE - 2 and MASSIVE - 3), the concepts of "focus" and "nimbus", which permit the virtual space to be broken up according to the current interactions. "Focus" of each one of the participants indicates the spatial zone to which the attention of the participant is directed, "nimbus" is – vice versa – the spatial zone in which participants selectively project their information. Other collaborative virtual systems are Distributed Interactive Virtual Environment (DIVE) [43], which can be used both from a normal desktop or in the immersive form, NPSNET [44], a 3D system designed by the Department of U.S. Naval Postgraduate School to simulate large-scale military training, and Scalable Platform for Large Interactive Environments (SPLINE) [45], created by Mitsubishi Electric Research Laboratories, which allows the creation of small regions (called "locales") that can be connected in different ways to forms worlds or networks.

The main advantage of the CVEs, from the point of view of the creation of a common ground, consists of embodiment: the participants can move within the environment, make gestures, try to express emotions (but the presence of anthropomorphic traits in avatars does not always have a positive effect on communication) [37, 46]). Above all, they can speak and manipulate the objects present in the CVE. It has however been noted, that sharing the same VE does not solve all the problems which the participants may encounter in trying to establish co-reference. Evidence by Hindmarsch et al. [46] show that participants to a CVE had trouble to complete a common task because they did not find the objects that other participants were referring to. The responsibility for the fact that a participant can have trouble in finding the object or the portion of space which the other participant is referring to was attributed to the fragmentation of the image (due to the narrow visual field both in 3D and in immersive conditions), which endangered the unitary character of the scene [47]. Often it was difficult for the participants - even with the help of verbal indications offered by the other participants during the interaction – to identify the indicated objects or to understand the indicative gestures made by the other participant.

Co-reference is not something, which can be taken for granted in CVEs on the basis of a supposedly "shared" environment. While in everyday situations actors make sense of the situations by means of a constant interplay between action and context, in which the meaning of the action is clarified by the context, and the contextual elements in their turn are made clear by the action [6, 34, 47], in virtual environments social actors find

themselves in a fragmented world and are scarcely supported by courses of actions which are themselves too fragmented to be easily understood [46]. This depends on the limited field of view available to participants in CVEs but it also depends on the absence of an immaterial element which is necessary for the construction of a social context: the set of routines, of social norms, of tacit assumptions which make coherent and predictable everyday environments [50].

### **17.7 The web of culture: making room for the learners' cultural resources**

What is missing in the reciprocal configuration of actions into objects, and vice versa, which takes place in the CMC? It is not realism [49], in spite of the fact that the graphic representation of the environment is not always perfect, but rather the set of shared beliefs and practices which each community uses to build everyday environments [50]. We call "culture" this set of shared beliefs and practices [51]. "The web of culture that holds people together in social groups - say Holyoak and Thagard - is constructed from shared beliefs and feelings, knowledge of a common history, and a sense of place in the natural and social world.

These strands provide the connections by which members of a society can communicate with one another... A culture is built and maintained in large part by symbolic stories and rituals, in which objects and events are given meanings that in various ways go beyond themselves. Analogy plays a prominent role in providing these extended meanings and thus in building and maintaining the web of culture." (p. 211).

The web of culture which produces meaning in a given community – the crew of a helicopter carrier of the U.S. Navy [52], or the members of the operations room of a large airport [53] – incorporates the history of that community and its present needs. Culture neither emerges from the interpersonal relationships [54] nor is made of conventional rules produced by the relationships among individuals. On the contrary the cultural web is the framework which makes possible the construction of a physical and social space shared among members of a given community. This web is not made of recipes, of rules to follow: "there is more to human culture than the image of cybernetic steering functions suggests" (p. 102) [55]. Culture is what organizes loosely people's everyday experience which maintains important degrees of ambiguity, of improvisation, of "non-order", as Rosaldo says: "a focus on non-order directs attention to how people's actions alter the conditions of their existence, often in ways they neither intend or foresee" (ibid). The more social actors face unprecedented situations, such as those they meet in VE, the more necessary a cultural framework is [56, 57] for them to make sense of such confusing experiences. What could be done in order to grow appropriate cultural reference points in meaning-based DL to favor development of sense making?

*First*, we should preserve a space for *ambiguity*, both in the situations suggested to the learners and in the virtual space of VE. It is necessary to give space for ambiguity in the design of the environments and in the interpretation of the results; sense-making presupposes ambiguity, it can be not grow without a sense of uncertainty. From this point of view it is important to explore the ways in which people construct their mediated environments, the ways in which they handle ambiguities both in virtual and normal world [58], the ways in which participants to a virtual environment designed for safety training reacted to the challenge of interpreting an ambiguous warning signal [59].

*Second*, we may take into account the cultural framework which is not an object out there in the world but a production of a community. The learners' cultural context in a DL system cannot be inserted into the system by designers, but should be created by the users of the system. We face the same problem that human-computer studies met in the 1980's: software designers were not aware of the cultural web, and were not even aware of the fact that they shared a technical culture which was often very different from that of the users. How could

distance learners be encouraged to fix cultural reference points which will help them to deal with the ambiguity which they encounter in learning systems? Our research experience encourages us to suggest attention to the functions that negotiation [60] and conversation [61, 62] have in transforming the abstract spaces of designers into meaningful places to be inhabited by normal people.

*Third*, we know that the cultural resources of a community of learners are resources which are called into action depending on the situation, on the task to be undertaken, and on the goals of the moment. Many DL and CVE systems are not really situated within the communities of practice which should bring into them their needs and their capabilities. Not only we lack clear rules about the correct use of the CMC – think for example of the difficulty of defining privacy in virtual space - but also the meaning of the new artifacts is not well defined. Occasions for confusion are great [63], and the future effects of the adoption of the new artifacts are not easy to foresee [64]. In the present situation it is important to do experiments on high-level learning mixing the resources of the different communities of technologists, social scientists, media experts, teachers, and especially learners [64]. A flexible and adapted cultural framework supporting meaning-making in DL systems can be only the product of patient negotiation among all the participants.

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