The making of Museum works as Smart Things

Hamid Bessaa, Florent Levillain, & Charles Tijus
Laboratoire Cognitions Humaine et Artificielle (CHArt), University Paris 8, France

Abstract

Most important purpose of understanding Human Behaviour in Complex Systems is the making of personalized Human-Artificial dialogs for task-oriented co-operation. Among complex systems are teams of Museum' works that cooperate to build the museum visitors experience (VX), as user experience (UX), to enhance the learner experience (LX). Until now, museums' artworks were passive things people cannot interact with. The "CULTE" project is to offer visitors the possibility to dialogue with connected artworks displayed in the Museum through I.O.T. Thus, as connected objects, Museums' artworks become Smart Things by enriching the visitor experience through trans-media dialogs. We report the rationale for our approach: a problem-solving based approach that is used for designing a smart personalized dialoguing system integrating (i) the context of Museum's complex system, (ii) an ontology of the "what's about" and (iii) the three necessary dialogs components that are the Pragmatic, meta-cognitive and, - as the core of the dialog -, the cognitive components. For the purpose of modelling, from less to more situated, the COGNITION component is embedded in the METACOGNITION component that is in turn embedded in the PRAGMATIC/SEMANTIC component.

Introduction

As User Experience, quoted UX, a concept introduced by Don Norman in the 90th to cover all aspects of the experience the person is having with the system (Norman, 2013), Visitor Experience, quoted VX, refers all aspects of the experience the person has with the artwork (Dubois et al., 2011).

As a consequence of technological innovations, VX increases because museums are expanding their system of communication with visitors: before, during and after the visit. Inside and outside the museum walls, visitors can get much more information with the artworks that are connected objects (IOT) and have richer personalized experience. However, if museums deliver this additional information by taking into account the visitor interest, they do it in a way that this is the museum that is talking to the visitor (*when and what*). The visitor is not talking to the museum and there is no dialogue between a visitor and a given artwork.

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CULTE[1] (*Cultural Urban Learning Transmedia Experience*) is a research project[2] funded by the French National Agency for Research (ANR) about an innovative transmedia pervasive Game which anchors the visitor experience with an in-situ application for Smartphone and an online post-visit platform beyond the museum's wall, in a continuum of visit. The game is also connecting the visitor with others museum's digital tools, which contribute to enhance its experience.

One of the most challenging dimensions of the visitor experience that will make people witnessing an innovative visitor's experience (VX) would be the possibility of dialoguing with any of the artwork connected objects of the Museum as being what we might define as Smart things. This both fundamental and applied research is in the line of research about dialogs with digital media (Bosser et al., 2007; Vandi & Djebbari, 2011; Astic, I., 2014; de los Rios, 2015; Holken et al., 2017).

In this article, we first define what smart things are, what they are made of and then how to design the dynamic interactive dialog of interaction of Smart Things with their users. This new kind of an interaction should be based on a dialogue that is embedded in the dynamic of the visitor route, taking dynamically into account their emerging interests while the process of dialoguing with artworks is evolving. To do so, we are developing the Verbal Interaction with Smart Things model (VIST) which is a general framework of interaction mode that can be used for any subcategory of Smart Things, although the use case reported here is the one of connected artworks in museums.

What are Smart Things?

First, Smart Things are Things which means that they are bearer of properties: "*A thing is always something that has such and such properties, always something that is constituted in such and such a way. This something is the bearer of the properties; the something, as it were, that underlies the qualities*." (Heidegger, 2017). A set of properties from which a typology was made: surface, structural, functional, procedural and behaviour properties (Cordier & Tijus, 2001). A typology that can be used for the design of intelligent, companionable objects, such as those designed by Chen et al. (2015) for the Smart Classroom.

In addition, Smart Things are objects that are connected (IOT) and dedicated for making people daily life simpler. "*Because Smart Things are taking decision for people and, for doing so, have to be adapted to their users, they are made of cognitive technologies that are technologies that include knowledge about human and about human cognition in order to process the data users are providing when interacting with Smart Things*" (Tijus, Rougeaux, & Barcenilla, 2016). In short, "*take the idea of*

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[2] *CULTE Partners are MQB (Musée du Quai Branly) - Jacques Chirac, Paris, France which is a well-known ten years old museum dedicated to the meeting ground of worldwide past cultures, CEDRIC Laboratory, Centre National des Arts et Métiers, Paris, France, a Game Design research laboratory; LUTIN, Cité des Sciences et de l'Industrie, Paris, France, a usability dedicated research laboratory for digital tools and MAZEDIA, Nantes, France, a multimedia agency, leader in France in the design of multimedia devices for museums.*

a human-centred approach to technology and run with it " (Norman, 2014). Based on "affordance", - that is to say the direct coupling of Action to Perception which is what the interface displays as actionable objects for command that seems to match the user's goal (Gibson, 1986; Norman, 2009) -, as well as object's usability based on categorization, reasoning and problem solving (Poitrenaud, Richard & Tijus, 2005, Tijus et al., 2014).

What are things made of?

First of all, things as objects have surface features (*colour, texture, size, shape...*). Although of objective evidence based on instruments to measure these visible properties (*spectroscope for colour wavelength, etc.*), these surface properties can match a user's mental representation positively providing affordance or negatively providing false alarm kinds of errors. Thus, for usage, surface properties can be more or less useful.

Things are made of structural properties: their parts and relations between parts and whole that determines in turn functional properties and procedural properties. Thus, things can be used as agent to act on another objects (procedure), realizing some functions that will transform this patient object. Functional properties (*what for*) as well as procedural properties (*how*) being properties attributed by knowledge or inference. Notice that automatic systems are things in which parts are acting on each other to realize some complex functions. This working machinery have behaviour property. These relations have to be used when dialoguing with users; particularly when things have to be Smart.

Relations do exist between these types of properties (Zibetti & Tijus, 2005). On one side, relations exist between structural, functional and procedural properties. On the other side, relations exist between surface and behavioural properties. Both can be used for inducing the adequate functions and procedures, then to trigger action, for instance for the "putting into place of affordances": indicating the where, when, how and on what to act. In opposite, no relation at all will decline accessibility, usability and learnability. Thus, our theory is that smartness comes from smart relations among properties: the relations that increase the guidance of the interaction with the smart thing.

What are Smart things made of?

Smart things can be either physical objects *(a robot*) or virtual entities (*an avatar*). In addition, there is smartness: the properties of automatic systems with autonomy, decision-making and adaptation behavioural robotic properties: "*the smart thing can trigger functions and apply procedure to be autonomous, to take decision and to be adapted while having a given appearance and a given behaviour at will. It follows that smartness is the set of relations between "functional - procedural" properties and "surface – behaviour" properties*" (Tijus, Rougeaux & Barcenilla, 2016).

Notice that interaction with smart things can be engaged and sustained mainly by appearance and behaviour. Thus, the design of a smart dialog systems, - as part of a whole Smart Thing-, might be based on appearance and behaviour (Levillain &

Zibetti, 2017). We argue that these properties, their relations, and the underlying logical arguments should be used for the design of smart things dialogs.

Interacting with museum artworks as Smart Things

With content based on the typology of properties of a given Smart Thing, this new kind design of verbal interaction should be based on a dialogue that is embedded in the dynamic of the visitor route, taking dynamically into account their emerging interests while the process of dialoguing with artworks is evolving.

Our approach is based on problem solving of explanation (Tijus, Ganet & Brézillon, 2006) in order to design dialog-based intelligent tutoring systems (e.g., D'Mello & Graesser, 2013). Although there are dimensions of dialogue such as emotion, empathy and sympathy, our proposal is about the three necessary components of a dialog: The Pragmatic dimension, the metacognitive dimension and the cognitive dimension.

More precisely, the core of the dialog is the cognitive dimension: the knowledge transmission from the Smart Artwork to the visitor according to her interest. For the purpose of modelling, from less to more situated, there is the COGNITION component that is embedded in the METACOGNITION component that is in turn embedded in the PRAGMATIC component (figure 1).

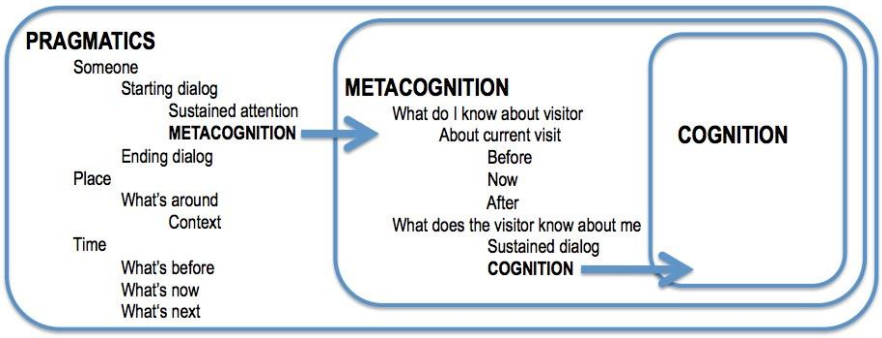

Figure 1. For a dialog-based intelligent tutoring system, the COGNITION component (knowledge to be delivered through dialog), which is the core of the dialog, is embedded in the METACOGNITION component (meta-knowledge about the purpose of the dialogue and its context), which is in turn embedded of the pragmatics of dialoguing (needs of an interested person, a start and end of the dialog, in a place and at a time for doing so).

In this brief paper, we shall first introduce the necessary dimensions of an epistemic dialog, which is a dialogue for knowledge transmission and the ontology of knowledge about objects that is to be transmitted, as well as examples of dialogs made by smart artworks in museums.

What is a dialogue for a smart thing?

People come to museums to meet things: to see them, to learn about them and to discover new domains of knowledge. Notwithstanding the fact that many works of art are sculptures in human form, it would be "smart" that people can discuss with the

artworks in the museum, as one of the possibilities of interaction. Such an epistemic dialogue would be more than profitable: it might enhance the visitor experience (VX).

Artworks in museums are already connected in a such way visitors can get supplementary information through interaction with some Smartphone (e.g., de los Rios et al., 2015). For instance, thanks to CULTE project, partners developed a transmedia editorial platform, which makes it possible for any museum to develop its own transmedia pervasive devices. Now, partners are going to extend the devices inter-operability and the space and time relationship between the visitor and the museum by adding an off-site mobile application. In that direction, Smart museum Artworks might be capable of discussion with the visitor; as well as being the trigger of the discussion with the visitor than as being triggered by the visitor for discussion. Because till now, much of interactions with museum artworks are determined only by the possibilities offered to the visitor (*ask for [that] by doing [this]*), such an interactive behaviour would be far from what exists.

Such smart things must be based on cognitive technologies that are technologies that include knowledge about human and about human cognition for cognitive processing in order to process the data that visitors are providing when interacting with them. Cognitive computing makes it possible the set of inferences on which dialogue can be built. For the online building of an epistemic dialogue with the purpose of knowledge transmission, the model needs the three embedded components as in Figure 1.

As display in Table 1, although not mandatory, the PRAGMATICS and METACOGNITION components [C-] shall be used to manage the epistemic dialogue. Many different sentences that match these components content can be used. For instance, when by image recognition “a particular person is a possible target for dialogue” [C-1.1], saying “Hello” [C-1.1.1], “Are you interested by me” [C-1.1.1.1], “I think you are because you are a pupil coming in this museum with your class and your professor” [C-2.1], “You have already seen other similar Artworks” [C-2.2.1], “but now you are facing something different” [C-2.2.2], and “I’m the last artwork in your visit” [C-2.2.3]. “So, you already know the country where I come from” [C-2.3], “what do you want to know about me? I have so much to say!” [C-2.3.1], “First of all...” [C-2.3.2], “... as other artworks in this room” [C-1.2.1], “such as the one in your back” [C-1.2.2], “we are talking for long” [C-1.3.1], “ and you already see so many things” [C-1.3.2], “the museum is going to close” [C-1.3.2], “maybe we shall say goodbye” [C-1.1.2].

The tree of categories of the PRAGMATICS and METACOGNITION components can be used to build adapted sentences, as well as to interpret the sentences produced by the visitor. The cognitive computing refers here as the categorization process of affecting visitors’ sentences to the pragmatic and metacognitive categories of human dialog. Note that these categories can be used to question the visitor when interpretation fails. Thus, the tree of categories of the PRAGMATICS and METACOGNITION components can be used to build adapted sentences.

Table 1. the tree of categories of the PRAGMATICS and METACOGNITION components can be used to build adapted sentences

C-1. - The PRAGMATICS components are the know-how about the dialogue process.
C-1.1. - Get [Someone] for dialoguing
C-1.1.1 - Have a [Starting dialog]
C-1.1.1.1 - Beware of and control [Sustained attention]
C-1.1.1.2 - Use the [METACOGNITION] component
C-1.1.2. - Have an [Ending dialog]
C-1.2. - Use Information about [Place]
C-1.2.1 - About [What's around]
C-1.2.2 - About [Context]
C-1.3. - Beware and control [Time]
C-1.3.1 - Use Information about [What's before]
C-1.3.2 - Use Information about [What's now]
C-1.3.3 - Use Information about [What's next]
C-2. - The METACOGNITION components is the knowledge about the dialogue content
C- 2.1. - Use Information about [What do I know about visitor]
C-2.2. - Use Information about [its current visit]
C-2.2.1 - About [Before]
C-2.2.2 - About [Now]
C-2.2.3 - About [After]
C-2.3. - Use Information about [What does the visitor know about me]
C-2.3.1 - Beware of and control [Sustained dialog]
C-2.3.2 - Use the [COGNITION] component

The following discussion is extracted from the dialog an artwork of the MQB (*Musée du Quai Branly*) is having a visitor. The name of the museum artwork is "Ashura". The related categories of the PRAGMATICS and METACOGNITION components are provided. " *Hello*! " [C-1.1.1], "*I am impressed with the idea of sharing with you*" [C-2.3.1], "*will you talk to me*" [C-2.3.1] "*about Fertility*?" [C-2.3.2], "*During your initiation, you learn that you should not trust appearances*" [C-2.2.1]. Then is "COGNITION" [C-2.3.2]. "*But according to you*" [C-1.1.1.1], "*do I have a link with the costume Gourgecha to my right?*" [C-1.2.1].

Thus, the epistemic talks entail the METACOGNITIVE component that entails the PRAGMATIC components. In the next section, we introduce the ontology of what could be known about a thing that can behave smartly when discussing about itself.

What a smart thing can tell about itself ?

There are basic questions about knowledge of things, such as "*Who, what, when, where, why, how*". However, they are not organized in a hierarchy of categories. To do so, we first consider that a thing is a bearer of properties (Heidegger, 1967) and these properties are the components of the COGNITION MODULE. There are extrinsic properties [C-3.1] and intrinsic properties [C-3.2].

Extrinsic properties do not belong to the thing. Thus, Place (*Where*) [C-3.1.1] and Times (*When*) [C-3.1.2] are extrinsic properties that provide the space and time context of the thing. This contextual knowledge (e.g., *where and when the thing was built*) provides relational spatial and temporal properties with other things (*are from the same/different country, were made at the same/different time*). Other extrinsic properties are causal properties [C-3.1.3]: what are the causes of the thing (e.g., *the author, the contingences...*).

In opposite, intrinsic properties are own real properties of the thing. Among intrinsic properties, there are surface properties [C-3.2.1] that are related to perception (e.g., *colour, texture, shape...*) and structural properties [C-3.2.2] that are related to physics: substance (*made of*) and materials (*the parts that composes the thing and how these parts are nested to form a given structure*). There are also cognitive attributed properties [C-3.2.3]: functional, procedural and behavioural properties that are linked to the usage of the thing and rely on structural properties. Finally, there are semantic properties [C-3.2.4] as the thing's name, or other analogical or metaphorical attributes of the thing.

The followings are sentences for a Mask artwork named Ashura Mask: "*I am an Ashura Mask*" [C-3.2.4]. "*My teeth are made of bone fragment*" [C-3.2.2]. "*I come from the oasis of the Algerian Sahara*" [C-3.1.1] "*in which there were happy masquerades in order to celebrate the Ashura festival*" [C-3.1.3], "*on the 10th day of the first month of the Muslim calendar*" [C-3.1.2]. "*It was at the time of an ancient agrarian fertility rite that has survived in some areas since Islamized*" [C-3.1.2]. "*I am of the types of Ashura masks that are called Zalouciou mask*" [C-3.2.4] because Zalouciou means "*Acolyte*" or "*companion*" [C-3.2.4]. They were made and worn by young unmarried men who accompanied a man dressed in his nocturnal wanderings in Gourgecha [C-3.1.3].

Conclusion

Smart things that are connected objects (IOT) are dedicated for making simpler people's daily life. They are of help for decision-making and problem solving. A number of objects are resources for teaching and learning. As smart things, they will have dialogue competencies and capabilities. Based on a categorization theory, we propose a model and an ontology to design the on-line building of an epistemic dialog. Although done for Museum's objects, the model, its components and the properties that define categories could be of use for designing a large number of types of smart things dialogs (inside a car, with a group of Smart things

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