PERSONIFICATION OF TOPICS WITH CONVERSATIONAL AGENTS

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ABSTRACT

Nowadays, ordinary people can freely access a large amount of information through Internet. Then issues of production and transport of computational entities are superseded by new requirements like: enticement, acceptability and understanding. To achieve these goals, we propose an approach based on dialogical interaction between novice users and conversational agents achieving the mediation of computational entities. The originality of the approach is based on the principle of personification of an entity by an agent, where the agent and the entity share a single identity.

KEYWORDS

Computational objects, Conversational agents, Personification.

1. INTRODUCTION

1.1 Facilitation of ordinary people interaction with abstract topics

Following the development of the Internet culture, general public can now access a plethora of computational entities through Web applications and services. Those entities, which we'll refer to as **topics** in this article, are data structures synthetized in order to mediate information (technical, encyclopedic, statistical…) to a targeted audience, with a given goal (didactic, institutional, social, entertaining, advertising…). Because of their abundance, these topics are in competition in order to: 1) reach their audience: it's the *enticement* issue (Galon, 1999), 2) not to be discarded immediately: it's the ergonomic *acceptability* issue (Davis 1989), 3) taken seriously: it's the *believability* issue, 4) to be properly understood: it's the *communication goal* issue. Hence, there is a need to develop tools for facilitating ordinary people interaction with such abstract topics, where the facilitation can be measured in terms of the four four listed above.

In this paper, we propose an approach to facilitate ordinary people interaction with abstract topics, which is based on their personification by Conversational Agents. Ongoing research in the very active research field of conversational agents (Maes 1994) has shown that they can increase the user-friendliness (Lester et al. 1997) useful for enticement), the acceptability and the believability (Hayes-Roth 2004) of the system, as well as increase the performance of the human-agent couple to learn new information. Hence, they appear as a promising approach to address issues regarding interaction of general audiences with topics.

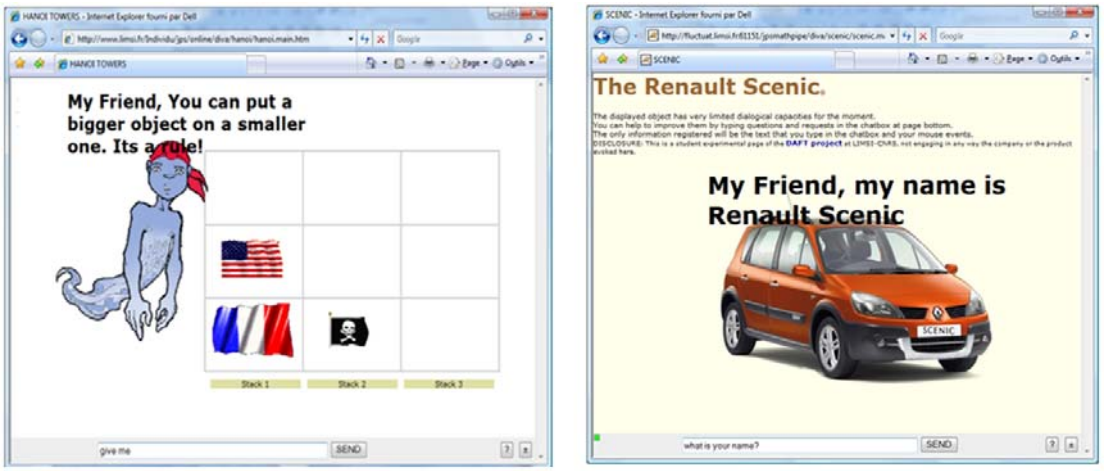

Figure 1. Left) A typical assistant agent integrated into a DIVA web page: the user interacts in natural language with the agent (in this case, it is a cartoon-like animated character but DIVA provides also realistic ones) **about** a simple game, which acts here as a topic — right) In this conversational situation, the user interacts **directly** with the topic (it is a commercial product personified by a static picture), which answers users' questions *as if the car were a person*. The DIVA toolkit is freely available for research and education purposes at http://www.limsi.fr/~jps/online/diva/divahome/index.html

1.2 An architecture for the personification of abstract topics

Traditionally, conversational agents are personified through virtual graphic characters and are studied in the context of Embodied Conversational Agents (ECA) (Cassell et al. 2000). In such a case, agents represent human-like entities and attempt at expressing relevant, believable, human cognition and psychology. Human cognition is often based on rational reasoning approaches, such as classical rule-based systems (ACT-R, SOAR) or now popular BDI-agent technology for Intelligent Agents (Rao and Georgeff, 1991). More recently, there have been attempts at implementing human psychology phenomena into Intelligent Agents, like for example CoJACK (Norling & Ritter 2004) (Evertsz et al. 2008) for the BDI platform JACK (Howden et al. 2001). Following the pioneering works on Believable Agents (Rousseau and Hayes-Roth, 1996), authors such as (Malatesta et al. 2007) use personality traits to create different expressions of behaviors, especially by influencing the appraisal part of the OCC theory (Ortony et al. 1988) etc.

When we are concerned with the personification of non human-like entities like the topics defined above, especially abstract ones, we face a contradiction: 1) They are not human-like in essence and their embodiment (e.g. their appearance on screen) is not human-like; 2) We state in principle that people should interact with them "as if they were human-like entities".

Taken in its generality, this issue has been discussed from the philosophical point of view (Nagel 1974). It has also been studied by psychologists since Piaget in the '30s and more recently studies upon children have linked personification of non human-like entities with notions such as *animism* prompting definitions: "Since Piaget [], psychologists have often claimed that young children are animistic and personifying []. Animistic means labeling inanimate objects as living as well as attributing characteristics of animate objects (typically humans) to inanimate objects and making predictions or explanations about inanimate objects on the basis of knowledge about animate objects. Personification means the extension of human attributes to any nonhumans" (Inagaki et al. 1987).

In order to support these requirements, we have to design a software architecture for conversational agents that enables the integration of conversational topics into Web pages. This architecture will be based on previous works on Conversational Assistant Agents (Sansonnet 1999, Sansonnet at al. 2002) and more precisely on the DIVA toolkit. Actually DIVA stands for DOM-Integrated Virtual Agents, which emphasizes the unique feature of DIVA agents to interact in natural language with users and to control directly the inner structure of the content of the Web page they assist (Bouchet and Sansonnet 2007, Xuetao et al. 2011). Figure 1-left shows a typical DIVA assisted Web page. The DIVA architecture has been easily adapted to support conversational interaction with non human-like entities, as shown in Figure 1-right. This raises the issue of the *interactional content* between users and topics, which is discussed through a case study developed in the next section.

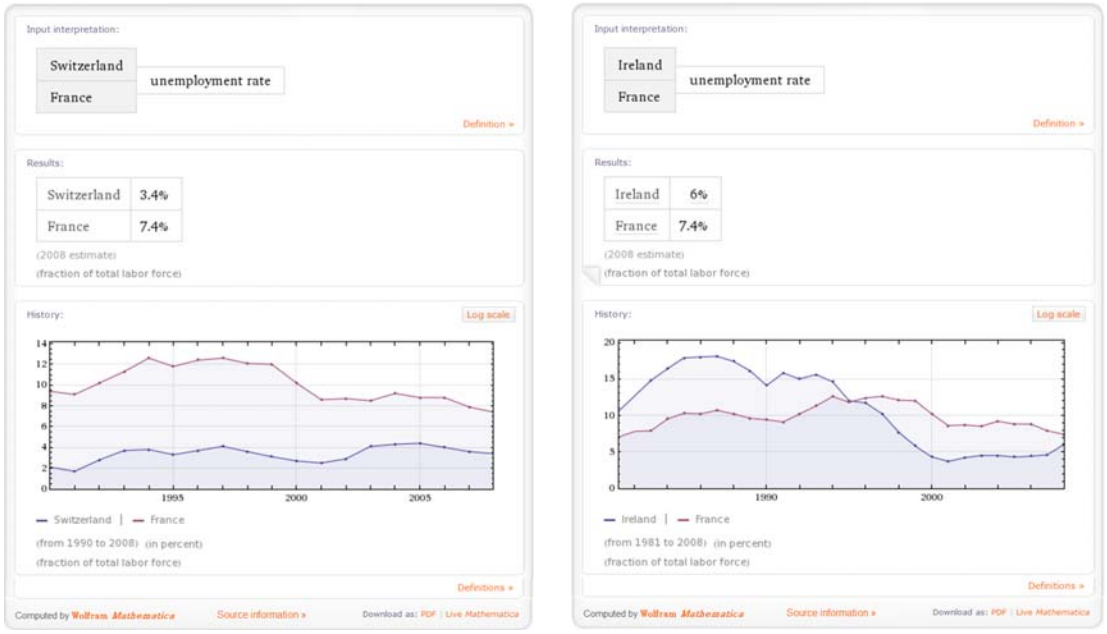

Figure 2. Left) Alpha answer to: "unemployment rate switzerland france" (upper part); right) Alpha answer to: "unemployment rate ireland france" (upper part).

2. PERSONIFICATION PROCESS OF AN ABSTRACT TOPIC

In this section, we develop a case study so as to exhibit the issues raised by the conversational interaction between ordinary people and abstract topics, on the basis of the metaphor of (Inagaki et al. 1987) mentioned above. The outline of the case study is as follows: first we choose a typical abstract subject, synthetized from Web sources that can be relevant for many people browsing the Internet. In the next sub section, a model of the agent associated with the chosen topic is briefly discussed and in further sub sections, we propose excerpts of both rational and psychological interactions.

2.1 Choice of a topic to personify

The case we propose here is willingly related to a very abstract phenomenon of interest: « Unemployment in France for the last 20 years ». This topic has been mentioned by many books and documentary films, and websites about it[1] provide data (including a lot of graphs) and text comments. Regardless of the stability of the information (*i.e.* static website versus wikis) they provide, data is difficult to process automatically for creating an associated agent. However, recent advances in Semantic Web for extracting data in order to build new documents have been particularly promising:

— *Alpha* by Wolfram Research[2], takes a Question&Answer (Voorhees 2002) type of request and provides as a result, not a mere text but a full Web page related to the user's question. Moreover, data retrieved by Alpha is now accessible directly from the latest version of Mathematica (8.0) under a symbolic format.

— *QWiki*[3] uses the Alpha technology to build even more sophisticated Web pages, both in terms of content and presentation.

Those two examples show that in the future, users will indeed be facing an abundance of topics of interest automatically synthetized as answers to their(s) request(s), and this is the reason why we have also decided

[1] See http://en.wikipedia.org/wiki/Unemployment for a first list of references

[2] http://www.wolframalpha.com

[3] http://www.qwiki.com

to use the results of Alpha requests regarding our aforementioned topic of interest. Two successive requests provide results shown in Figure 2 (only the upper part of the results Alpha Web page is given here).

2.2 Building the agent model

In section 1.2 we have mentioned that authors have tried to integrate psychological phenomena into traditional Intelligent Agents architectures. However, psychologists have shown how rational and psychological human behaviors are extremely entangled (Frijda 2006) (Scherer et al. 2001). In this context, we have proposed in previous works (Bouchet and Sansonnet 2009) a framework, called R&B — standing for Rational and Behavioral agents. This framework dedicated to the experimentation of conversational scenarios, where both rational and psychological behaviors are mixed according to various strategies.

In this section, we will assume, as it has been explained in section 2.1, that the agent and the topic are merged into a single entity, meaning that the user talks to the topic as if it were a person. Hence, one must be able to provide a conversational agent tightly related to the topic, which must be a multimodal mediator of the topic informational content. Based on framework R&B principles, two modes of answer are then required:

— *Rational expression*: users should be able to put natural language questions to the agent-topic and to receive factual answers in return, which requires storing facts into the Knowledge Base (Kbase) of the agent.

— *Psychological expression*: the agent and the topic being viewed as a unique entity, this identity must be reflected in the mental states of the agent and it should affect its multimodal expression. To achieve this, facts should be related to the mental states of the agent, *i.e.* to the part of its Kbase that models its psychology.

The association between objective facts and their rational and psychological expression is not neutral: it requires decisions and interpretations from the agent's designer:

- For the rational part, it is about selecting which facts should be entered into the model or not, *i.e.* what notions the agent will be able to comment and talk about.
- For the psychological part, it is about defining influence operators over the mental states of the agent.

In both cases, one must have some kind of judgment regarding the data provided in the answer, which will depend on *who* will express the information (that is who is supposed to be the agent?) and to *whom* it will be transmitted (that is who is the user?). Hence it is crucial to properly define the roles and the communicative goals of the actors of the interactional session.

For instance, in Figure 2-Left, one can read the objective fact ϕ = *"unemployment rate in France is now of 7.4% against 3.4% in Switzerland, and the difference is stable over 20 years as shown by the graph"*. With regard to this kind of information, the agent's designer has to adopt a role among the following ones: Swiss, French or Other. Independently from the difference between the numerical values, the designer also needs to have a communicative goal: *e.g.* to enjoy about the stated differences (whether they are positive or negative), to bemoan it or to minimize their relevance. In the same way, the user also has a role (he/she can be Swiss, French or Other) and has a communicative goal that can be obtained either explicitly or inferred by the agent according to the user's profile. This simple combinatory entails a set of possibilities that can't be all considered here – indeed, if we consider only the possible nationalities and if we use a stereotypical model of nationalism, we could have:

User	Agent	Agent's reaction about ϕ
French	French	sad
	Swiss	arrogant
Swiss	French	proud
	Swiss	enjoying

That's the reason why in the rest of this case study we'll assume both the agent and the user are French, and the communicative goal is to emphasize the absolute value of the difference between the countries, and to regret it if it's unfavorable. Table 1. provides symbolic information related to rational and psychological expressions for this topic. Globally, the rational part stores the absolute value of the difference (Rate-unempl-F) and the difference between the two involved countries (Dif-unempl-FS, Dif-unempl-FI), while in the

psychological part, two moods are connected to the difference between the countries according to formulas (1) and (2) in Table 1.

Table 1. — Summary of the symbolic model of unemployment rate difference between France and Ireland/Switzerland.

Domain	Operator type	Attribute	Format	Link	
Rational	δ_t	Rate-uneempl-F	List	plot values	
		Dif-unempl-FS	List	plot values	
		Dif-unempl-FS	List	plot values	
Psycho.	Δ_{mood}	Satisfaction	scalar [-1,1]	F - I	(1)
		Confidence	scalar [-1, 1]	F (S+I) / 2	(2)

2.3 Dialogical interaction using the rational expression

Let's assume the user asks from the agent a purely factual question about the topic:

USER: "*What's the current unemployment rate in France?*"

Moreover, let's assume that among the patterns associated to the rational attribute Rate-unempl-F is the rule:

QUEST& /unemployment rate france/ $\Rightarrow$ Comment(Rate-unempl-F)

Triggering this rule means the agent reads the value of the attribute Rate-unempl-F in its KBase and can comment it in a multimodal way to the user. The commenting strategy is linked to attributes with rules like:

Comment (Rate-unempl-F) :=
IF val<0. THEN Play SORRY & Say "(Sadly | Unfortunately), it's @val %" ;
ELSE Play HAPPY & Say "The unemployment [rate] in France is only of @val %"
Where @val is dynamically replaced by the value of the attribute in the answer.

This interaction is above all rational : the user asks for a value and gets it in return. It is however possible to add to the answer some psychological content through a judgment over the raw fact. We can use for this two expressive modalities:

— Operator Say builds a natural language sentence (using options [] or picking among alternatives for variety with |, etc.) and displays it in the answer area.

— Operator Play triggers an animation that emulates the expression of emotions or emotes[4].

For instance, we could have the following multimodal answer ("sadly" willingly emphasized here):

AGENT: "*Sadly*, it's 7.4%" + SAD

2.4 Dialogical interaction using the psychological expression

In this section, we provide an example involving the static traits and the dynamic moods composing the mental states of the agent. We analyze the different possible combinations of the following elements:

— *Static traits* are specified once and for all by the agent's designer depending on: a) the personality profile associated to the topic, b) the type of interaction expected (information, entertainment…). Their automatic elicitation is beyond the scope of this study.

— *Dynamic moods* are linked once and for all by the agent's designer to the topic variables, *i.e.* data that is evolving with time, either because a) the topic itself is dynamic (its values can change throughout the

[4] In traditional ECA environments, simple emotions (joy, anger, surprise, etc.) or more complex so-called emotes gestures (beware danger!, so bored, etc.) are expressed through graphical animations of the agent's character. In this case, the graphical representation being more abstract (*e.g.* plot, technical graphics) we have to find ways to express emotions through alternative modalities. These ways are not discussed here because their elicitation, in each specific context, is an issue in its own. See for example (Sansonnet et al. 2010) in the context of agents in ambient environments.

session) or b) the topic is static (like here) but contains values that have been evolving in time (cf. the graphs illustrated in Figure 2), in which case it should be possible to prompt the user "to browse through time" in order to get back to case a.

Example: Linking mental states to data

We will consider one trait and two moods:
— Binary (yes/no) trait Talkative which means that: yes = the agent provides lots of information; no = the agent restricts to minimal information when asked.
— Moods Satisfaction et Confidence, which take values in [-1, 1], 0 being neutral. Satisfaction is related to cognitive happiness while confidence indicates the degree of certainty about a fact.

When it is possible to access data used to generate the graphs, one can link the values of the graphs to the internal mental states, as shown with formulas (1) and (2) in Table 1. More complex relationships can take into account the derivative or integral over a period of time. The graph from Figure 2-right, using formula (1) shows that the psychological attribute Satisfaction of the agent evolves over time from a negative to a positive value when the two curves cross in 1995 (thus triggering a data event), then gets back to a neutral value in 2000: the agent *psychologically lives* the evolution. The same analysis can be done for Confidence with the formula (2).

In this context, if the user asks the agent how it feels, like one would do for a companion:

USER: *"How do you feel?"*

Using a rule of the list of patterns associated to the psychological behavior of the agent, like:

QUEST & /(you feel|are you)/ $\Rightarrow$ Express(Talkative, Satisfaction, Confidence)

would lead to a set of possible reactions according to the static (Talkative) and dynamic (Satisfaction and Confidence) mental states of the agent, summarized in the heuristic below:

Express(Talkative, Satisfaction, Confidence) :=

Talkative	Satisfaction	Confidence	Natural language answer	Emote
Yes	>0	>0	"I'm [quite|very] confident"	HAPPY
		<0	"I'm (ok|fine)"	NEUTRAL
	<0	>0	"I'm sad, but determined"	NEUTRAL
		<0	"Ouch! Everything is wrong!"	SAD
No	>0	>0	"Everything is fine"	NEUTRAL
		<0	"(Err|Hmm)…"	NEUTRAL
	<0	*	"…"	ALOOF

2.5 Discussion

Extension: argumentative interactions using additional agents

In the proposed approach, the topic of interest interacts directly with the users. A more traditional approach is also possible, where additional agents can be added on the Web page in order to interact with users **about** the topic, as shown in Figure 1-left. This can prove useful to extend the architecture with *argumentative* agents.

Indeed, it is a current trend, particularly observed in online social networks, to share opinions and to debate in a participative context. A way to motivate the general public to get interested in a given topic and also to better understand it, would then consist in offering a personification of this topic with an *argumentative agent*, which extends the concept of assistant conversational agent by providing it with argumentation skills (Kakas & Moraïtis 2002) (Bentahar et al. 2007), and by making it have positive/negative/neutral opinions about phenomena related to the topic. In this case study, we had considered that the situation was stable with regard to roles and communicative goals but it can also be dynamic. Moreover this can be applied with additional agents:

— with a single conversational agent: for instance, at the beginning of the session the agent has a neutral position and changes its attitude depending on the user's identified opinion, either to take the same one (empathetic interaction) or an opposed one (entering into debate).
— with three conversational agents: in this case, each of them takes one of the possible positions (positive, negative, neutral) in order to enter into an argumentative interaction with the user.

In all cases, the objective is to induce users to interact with the facts associated to a phenomenon of interest though an activity that they consider enjoyable in itself (*e.g.* a chatting activity).

Generalization: towards automatic personification

In this paper we have chosen to present the process of personification of an abstract entity through a single case study, which raises the issue of the genericity of our approach. Beyond the mere feasibility demonstrated here, we can put forward two main arguments are in favor of genericity:

1) A lot of works have ben carried out in automatic extraction of information from data (data mining etc.). Hence, it is possible to rely on existing algorithms for detection of status differences (Figure 2-left) or "data events" (*e.g.* curves crossing in Figure 2-right) to automatically fill rule patterns as shown in Table 1.

2) Conversational roles are quite generic (*e.g.* to take a positive, negative, neutral position about a status or an event) as well as communicative goals. They can be captured into rule-based heuristics that in turn can be instantiated for each particular domain.

Experimentation: evaluation of the impact of conversational topics

Because this work is preliminary, it is premature to state that conversational topics have a better impact (in terms of the four main factors listed in section 1.1, that is enticement, acceptability, believability and understanding) upon ordinary people than non interactive topics like those presented and discussed in blogs for examples. However these factors are well-studied in ECA community and it has been proved that conversational agents can bring significant improvements. Consequently, we can rely on these results and confidently expect that they will extend to non human-like entities.

Moreover, implementations of conversational situations involving non human-like entities have already been developed and can be accessed on the DIVA Web page (URL at Figure 1.). They will be an operational support for further investigations upon the four factors.

3. CONCLUSION

We have presented an approach meant to facilitate the mediation between novice users and the abstract computational entities, such as those produced automatically in the Web. This approach is based on the principle of personification, which identifies the subject of interest (the topic) with a conversational agent, given both rational and psychological reasoning skills. Using our previous works on assistant conversational agents, as well as on works in psychology, we have proposed a method to build an agent associated to an entity, using a case study that illustrates the various problems encountered during this process.

The case study led here provides a first positive answer to the question of feasibility. It also shows that it's a vast domain still largely to explore, involving many different disciplines (agents, natural language understanding, psychology, semantic web, data extraction…). Two main questions would then have to be addressed: how to move toward an automation of the synthesis of the agent-topic identity once given a particular topic (and also how to profile both the designer's and the users' communicative goals), and what experiments could confirm the validity of with regard to enticement, acceptability, believability and understanding.

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