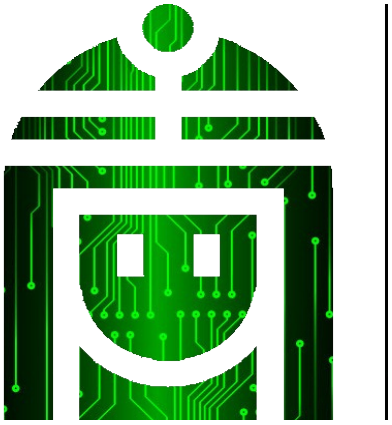
CLEOPATRA

CoLlaborative ExploratiOn of cyber-PhysicAl culTuRal lAndscapes



cleopatra-project.cloud

Cleopatra Project Deliverable: D1.1

Collaborative Models

Authors: Salvatore Venticinque, Massimo Ficco, Rocco Aversa, Angelo Ambrisi

Università degli Studi della Campania *Luigi Vanvitelli*

Dipartimento di Ingegneria

Dipartimento di Lettere e Beni Culturali

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

About CLEOPATRA

The Cleopatra Project aims at increasing the knowledge of the archaeological and historical-artistic sites and to develop new communication techniques for Cultural Heritage. The objective is to promote and rediscover the sense of history and cultural identity by the valorisation of lesser-known areas and sites of the Campania region, but no less interesting.

Two experimental scenarios will be designed proposing "Diffused Museums", through which the territory is known, and developing archeo-trekking or slow-tourism (i.e., cycling tourism), based on the protection and preservation of places requiring responsible, personalized and non-massive use.

The projects aims at achieving the following objectives:

- the creation of user friendly services both in outdoor (archaeological sites, squares, etc.) and indoor spaces (historic buildings, museums that store material documentation), in order to structure thematic itineraries through history, culture and art that involve the territory in its entirety for the construction of an integrated network for tourism promotion which is currently lacking;
- the organization of a system to guide the tourist, combining, from time to time, archaeological and historical-artistic, naturalistic, faunistic and geological elements based on their interests through an informative support; in the case of scenario 2, its peculiarity is emphasized by the naturalistic and geo-environmental background, in which the archaeological sites are located: currently they can be visited only with the aid of expert touristic guides;
- the realization a close interaction between user and avatar; the avatar will guide the tourist to places of difficult access through vocal and visual advices, choosing the most suitable routes based on a series of criteria, such as the available time, the ability of users to move in difficult contexts, clothing and the possibility to take scenic routes; at the same time the user, in his interaction with other users, can recommend new paths and report new elements, thus providing starting points for future research;
- to overcome problems, thanks to the help of the avatar, such as limited interaction with text documents, especially in open spaces, the lack of user, and an insufficient or wrong location of POIs.

For more information

Prof. Salvatore Venticinque, *salvatore.venticinque@unicampania.it*

Prof. Giuseppina Renda, *giuseppina.renda@unicampania.it*

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

Executive Summary

This deliverable starts from the original concept of “Diffused museums” to define requirements for implementing collaborative models. Collaborative models will be used to build applications which foster the social fruition of cultural contents and to exploit a distributed paradigm for composing cyber physical system in which the interaction among users, software services and multi-media contents.

This reports presents the design of a set of interaction protocols which will allow for the participation to collaborative models by human users and software agents. Multi-users conversation is introduced as a pillar to allow for the social interaction in a cyber-physical system. Context awareness and gamification are other two pillars which characterize an original approach to social fruition of cultural contents

A common communication mechanism is exploited for enabling the conversation among human users and software agents, but also as a transport channel to exchange data and controls between distributed sensors/applications and software agents to allow for context awareness.

Finally, we elementary interaction protocols, which will be used as building blocks, to build more complex collaborations in each specific use case of the Cleopatra project, or general scenarios.

The research leading to these results has received funding by the University of Campania “Luigi Vanvitelli” from VALERE 2019 program.

Table of Contents

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

List of Figures

List of Tables

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

List of Abbreviations

Table 1: List of abbreviations

Abbreviation	Explanation
MUC	Multi Users Chat
MAS	Multi Agent System
NLP	Natural Language Processing
XMPP	E**x**tensible **M**essaging and **P**resence **P**rotocol
KB	Knowledge Base
NFT	Not Fungible Token

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

1 Motivation

Current economic and urbanization trends place significant pressure on urban resources, systems, and infrastructures and demand for novel approaches in governing, financing, and monitoring urban performances with particular attention to abandoned, unused, or underutilized cultural heritage, defined "waste heritage."[1]

In order to enhance the exploitation of underutilized cultural heritage we design here collaborative models , which involve several actors of the application domain, conceived to facilitate the participation of visitors, to augment the visitor's experience with advanced services and enriched contents, to foster the collaboration between main cultural bodies. The proposed collaborative decision-making will be based on:

- Collective communication and interaction mechanisms
- Context aware services
- Gamification

The main actors of the Cleopatra platform will be software agents and human users who interact according to well defined collaborative models. Moreover

1.1 Multi-users conversations

The participation of software agents to multi-user conversations is an open research topic. In [1] authors highlight that current chatbots are designed primarily for dyadic interactions with chat-oriented and/or task-oriented roles. According to a statistic made by the authors, about 90% of the articles in the literature is focused on dyadic chatbots. An example of multiparty interaction shows a novel experience, where users interact with multiple, text-based conversational systems as if they were sitting around a table [2]. Another survey is presented in [3], where a classification of different tasks is performed regarding the analysis of the multi-participant chat and the research areas that motivated these tasks. Authors highlight a lack of widely-deployed techniques for automated analysis of multi-participant chat, which if available could aid a large variety of users and data analysts.

1.1.1 Parallel conversations versus multiple threads

Usually, a dyadic agents can handle many conversations in parallel, each one with one user, but each conversation proceeds independently from the others. They are isolated communications, and the first message from a user represents the beginning of a new conversation.

A not dyadic agents needs to identify and manage multiple conversations at the same time. Messages can be received from any senders on a public channel, where everything can be read by other participants. When the messages is sent from a different user, the agent cannot assume that a new conversation is starting from scratch, because previous messages have been eventually read in the public chat by the user himself. A conversation includes messages from different senders, which start or participate to some threads at any time. In each thread, the agent cannot neglect what it has been discussed before. Moreover, messages can be received on a private channel by the same senders. In this case, the conversation must be handled as a thread of the same conversation, because the agent cannot neglect what the sender said on the public channel and must care about the private conversation in order to decide what to post in the public channel. Moreover the agent must take into account that the private messages are not automatically disclosed to the others.

[1] https://www.intechopen.com/chapters/71887

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

1.1.2 Own messages versus multiple receivers

A dyadic agent is the receiver of each incoming message. In a multi-users context the receiver of the message can be undefined (addressed to all joined users), can be a public message tagged with a specific receiver (the agent itself or another user who joined the conversation), or can be a private message to the agent. The receivers could be also implicit, in the sense that the body of the message specifies that the it is addressed to all the participants who satisfy some conditions. Obviously, this issue requires the capability to distinguish multiple communications patterns within the conversation or within one thread. In particular, the last one requires to understand the semantic of the message body.

1.1.3 Replies versus posts

A dyadic agent always tries to reply to the received message. In a multi-users conversation, when the agent is not the explicit receiver of a message,it needs to understand when it should or it could respond. In particular, the response could be not required or not expected from the agent, or could have been already provided by others before the agent is ready to respond. A response could depend on a sequence of messages, for example, the choice among exclusive options or a vote. A response could not be timely, as a bid not valid anymore in an auction. We can say that when the agent is not the explicit receiver of a message, it will not reply, but it will make a decision about posting a message. Of course, it could send messages proactively, but usually such an initiative can be programmed as a reaction to some events (long silence, connection of a new users, disconnection of a user, situations awareness, goal activation).

1.2 Context aware services

Intelligence is defined as the capability by a software agents to adapt its behaviour to the context. For this reason, to augment the intelligence of the Cleopatra Platform, it is relevant to make aware software agents, which implement platform services, about the dynamic condition of user's context [4].

As it is shown in Figure 1, such knowledge about each user can be built collecting heterogeneous information by:

- direct requests to the users in natural language or trough multi-choices
- collection of environmental information (GPS position, image recognition, tag detection, qr-code scan)
- notification of events by client-side application, which are originated by the user interaction with the application itself

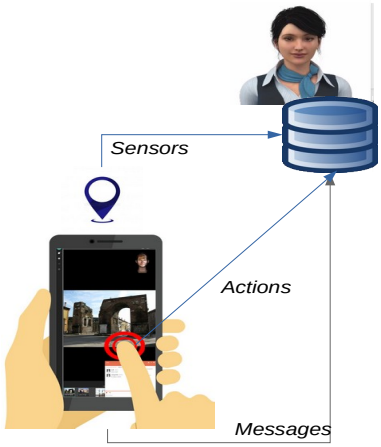


Figure 1: Input to Context Awareness

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

1.3 Gamification

Gamification will be investigated to engage users and to foster the social interaction, in order to increase the interest toward cultural experiences by a wider and heterogeneous groups of people.

Gamification is configured as the use of video games mechanics and dynamics within non-gaming contexts, to create engagement [5]. More simply, "it is the use of game design elements in non-gaming contexts" [6]. Thus, a series of schemes experimented in video-games are used to invite the user to perform specific actions, make choices, to reward him in an intrinsic (triggering emotions in it) or extrinsic (points, prizes, etc.) way.

In particular we aim at investigating the following categories of gamification:

- *pontification*: it is a subcategory of gamification [7] and uses a basic points/reward scheme to move the user from point A (personal sphere) to point B (company sphere of interest);
- *serious games* [8]: they are virtual environments designed to develop skills and competencies transferable to the real world [7]; and
- *serious urban games*: they are playful and organized offline practices that take place in urban environments with some kind of technological/digital support, which serve social and cultural purposes [9] and transform urban spaces into a sort of playful interface.

In the selected case studies, we aim at complementing a social experience driven by story-telling software agents proposing challenges, which need the interaction among users or other actors, (physical or virtual ones such as cameras, displays or avatars).

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

2 The application context: Diffused Museums

Two experimental scenarios will be designed for the valorisation of lesser-known areas and sites of the Campania region, but no less interesting, through two of their most identifying historical phases, proposing "Diffused Museums" through which the territory is known, and develop archeo-trekking or slow-tourism (i.e., cycling tourism), based on the protection and preservation of places requiring responsible, personalized and non-massive use.

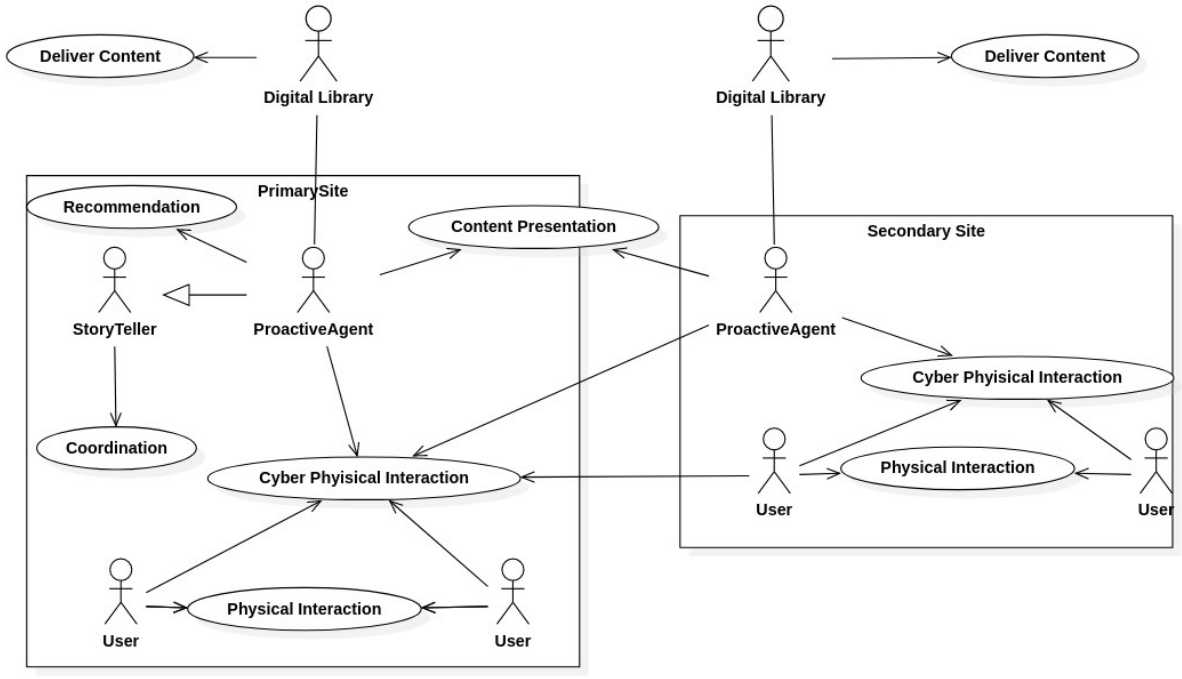


Figure 2: Use Case for Diffused Museums

The Use Case diagram shown in Figure 2 provides a high level representation of the cyber-physical collaboration among software agents and human users, enjoying a diffused museum. Each user belongs to a primary site (the one she is visiting live or she has joined virtually). In such an environment, she can communicate with other human users or with Proactive Agents located in that site. One Proactive Agent per site is in charge of leading the interactive storytelling and of coordinating the group of users, whose are visiting that site. It plays its role sending messages or presenting digital contents, but also suggesting the interaction with other agents and users located in secondary sites. Even tough, the social interaction between remote users is free, the interaction among local users is monitored and controlled by the local Proactive Agent to maximize the utility of the social experience, leveraging an emergent social behaviour. On the other hand, any secondary Proactive Agent can answer to primary users, or can be stimulated by the primary Proactive Agent to participate to the conversation, but cannot start autonomously any action in order to not affect the local coordination. We assume that each Proactive Agent has its own knowledge about the digital library, describing its own site and eventually is aware about semantic link to cultural content belonging to other sites. In this way, it can recommend virtual or physical itinerary across other sites or can invite, during its storytelling, other Proactive Agents to present related cultural contents.

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

2.1 Actors

- *Users*. We intend human users who enjoy the cultural contents using the Cleopatra platform. They can interact both with other users and with software agents exploiting social channels and/or Cleopatra applications.
- *Cultural Heritage Administrators.* We intend human users who represent private or public bodies and publish and made available cultural contents according to specific technical requirements and formal agreements.
- *Agents.* These are intelligent software which are context aware and are able to support single users and groups while they enjoy the cultural environments, both physical and virtual.
- *Sensors*. These are services which provide to agents information about the user's context.
- *Applications.* They provide to users presentation mechanisms to enjoy cultural contents and services and allow for the interaction with other users and software agents.

2.2 Cyber-physical collaboration

In Figure 3 collaborations between Cleopatra actors are based on three different kinds of interactions:

- *Cyber-interactions* occur between software agents. Agents can run at the back-end, where they offer services, and at the front-end, on client devices. They can also occur between users who communicate via software applications.
- *Physical-interactions* occur between human users, but they can also refer to their interactions with on site installations.
- *Cyber-physical interactions* occur between users and software agents in a direct way, both using natural language and interacting with controls of client applications. In the last case front-end agents implement a bridge between the real and the virtual world. Sensing functions contribute to enrich the cyber image of the real world. In the same way, actuators can execute controls sent by software agents.

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

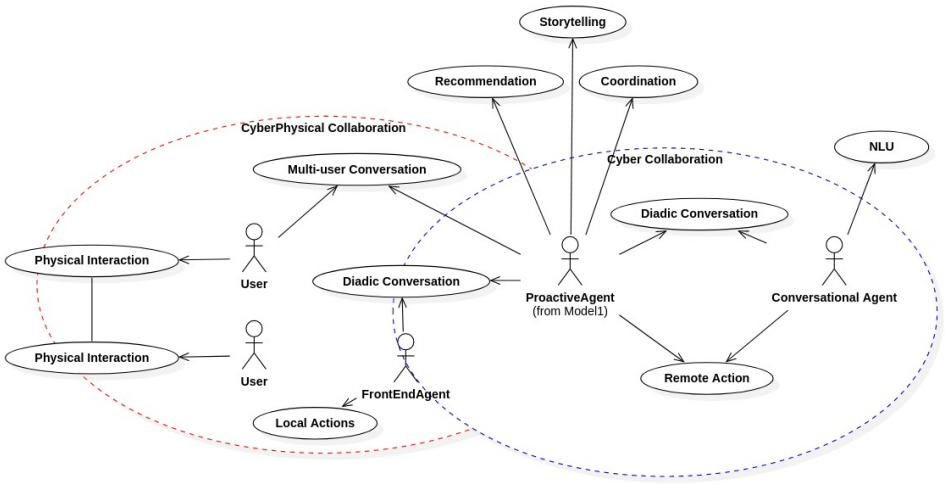


Figure 3: Cyber-physical collaboration

2.3 Interaction types

In Figure 4 software components participating to the cyber-physical interactions are shown.

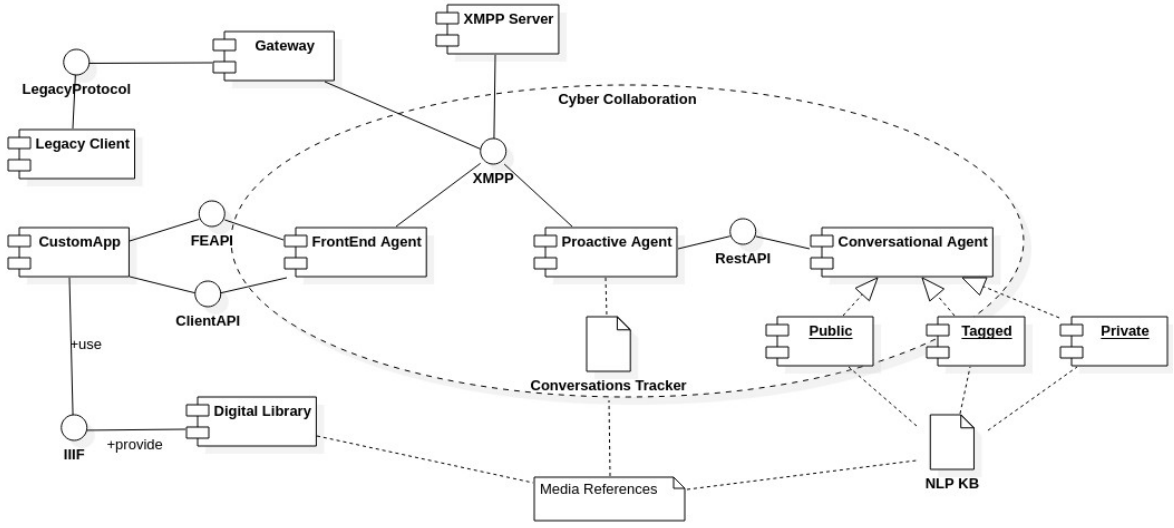


Figure 4: Cleopatra - Component Diagram

Agents to Agents interaction include:

- *Proactive Agent and NLP Agent*. Proactive Agent has not NLP capability. Such kind of interaction is used to converge all the diadic conversations which are handled by a NLP Agent as independent sessions trough shared channel when the messages are exchanged in a multi-user chat, or trough independent communication when they are private.
- *Front-End Agent and Proactive Agent*. This kind of interaction allows the communication of events detected at client-side or environmental information and, in the opposite direction, of remote controls. Also in this case the interaction is implemented as a message exchange.

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

- *Proactive Agent and Proactive Agen*t. A Proactive Agent may ask another Proactive Agent, to contact the user or a group of user for presenting, providing information about related contents which have been relevant in the current situation. The new Proactive Agent could become the primary contact of the user if he take some specific choice.

User to Agent

- *Multi-users conversation*. Users can interact with agents in a multi-conversation, where all exchange messages are public. In this case the user addresses his requests directly to the agent. The agent has to answer and other participants see the exchanged messages. On the other hand agents can send proactively messages to all users proactively to foster the emergent behaviour
- *Private conversations*. The user has a private conversation with an agent. The user can start the conversation on a private channel or the agent itself may decide that the the response (or am asynchronous message) must be sent on a private channel.

User to User interactions include

- *Public conversations* among users who converse can send message to everyone or addressing a specific receiver. These conversation should be analysed by Cleopatra to evaluate user's satisfaction or to learn how to improve the contents and the agents' knowledge and expertise.
- *Private conversations* which in principal cannot be seen by software agents.

Applications to Agents interactions include:

- *Event Notifications*: gps position, face recognition, QRCode scanning and other information which are collected by sensors or asking directly to the user.
- *Application events:* relevant events collected by the interaction of the user with a GUI and which are notified to software agents.

Agents to application interaction include:

- *Control signals*, which are sent by agents to client application to interact with the user by the GUI (e.g. change the user's view).

2.4 Communication Mechanisms

The proposed collaborative models is based on legacy protocols and technologies which allow a seamless integration of end-users applications and software services.

In particular, the basic mechanism consist of a peer to peer message exchange among members of a multi-user conversation.

Jabber is the standard protocol, which support the interaction between both intelligent software agents and human users.

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

On the other hand, multi-channel communication mechanisms are used for presentation of textual and multi-media content, and to reach a larger number of user by social channels. Additional information are provided in "D3.1 – Presentation Mechanisms".

The MUC (Multi User Chat) is the XMPP implementation of a many-to-many conversation by a conference room.

Exploiting such a mechanisms we support three kinds of interactions:

1. public on-to-many message
2. public tagged message
3. private one-to-one message

2.4.1 Private messages

In Figure 5 the user send a message directly to the Cleopatra Agent that respond in a private conversation. Neither the request nor the answer are forwarded to other users.

The Proactive agents exploit the NLP capability of the conversational agent.

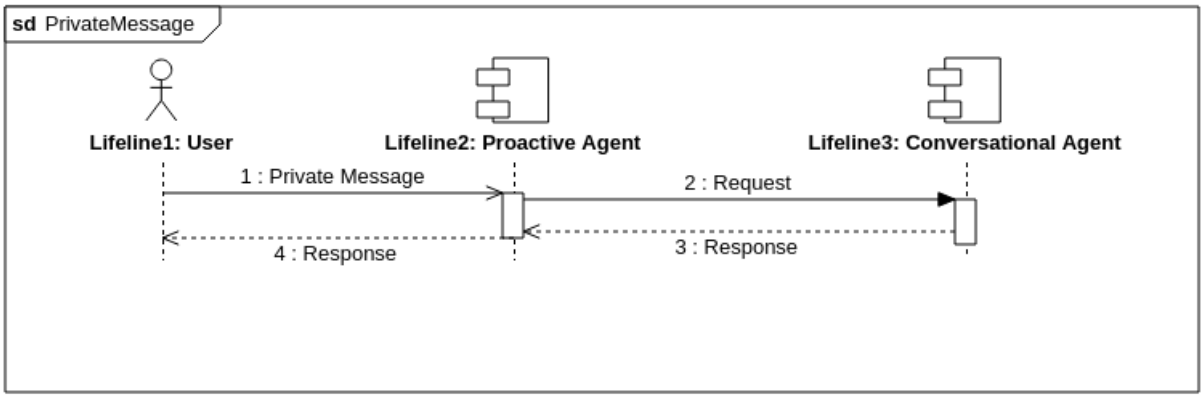


Figure 5: Private ono-to-one message

2.4.2 Tagged messages

Tagged messages are sent in a multi-users conversation. They are visible to all participant, but they have a well defined receiver. In Figure 6 the user sends a tagged message to the Cleopatra Agent. The Cleopatra Agents respond to the message and the response is post in the multi-user chat. It means that other participants to the multi-users conversation can see both the request and the response.

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

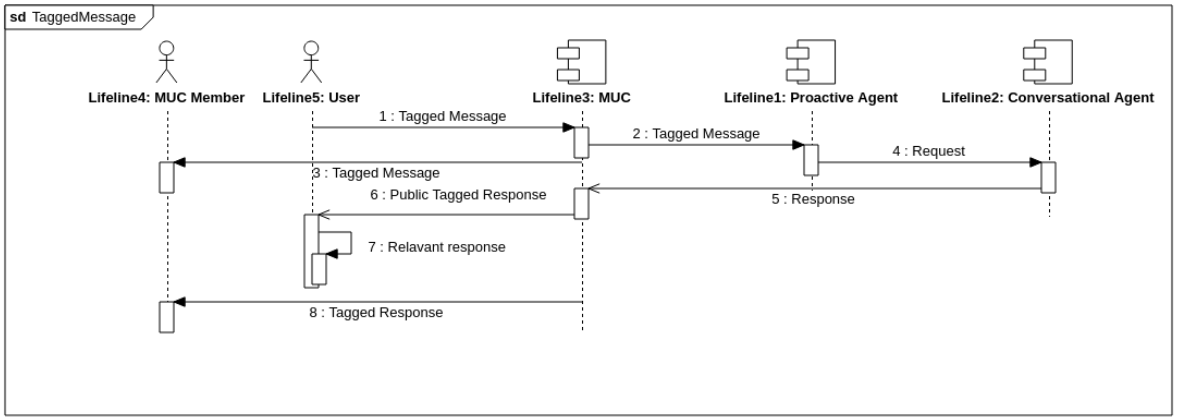


Figure 6: Tagged messages in multi users conversation

2.4.3 Untagged messages

Untagged messages are posted into the multi-users conversation without a defined receiver. In principle the Cleopatra agent does not respond to these messages. It store and process them (periodically, offline or on message arrival) by complex NLP elaboration to detect particular situations or events. The results of the elaboration could be used to update asynchronously the context awareness, the NLP capability or to send recommendations.

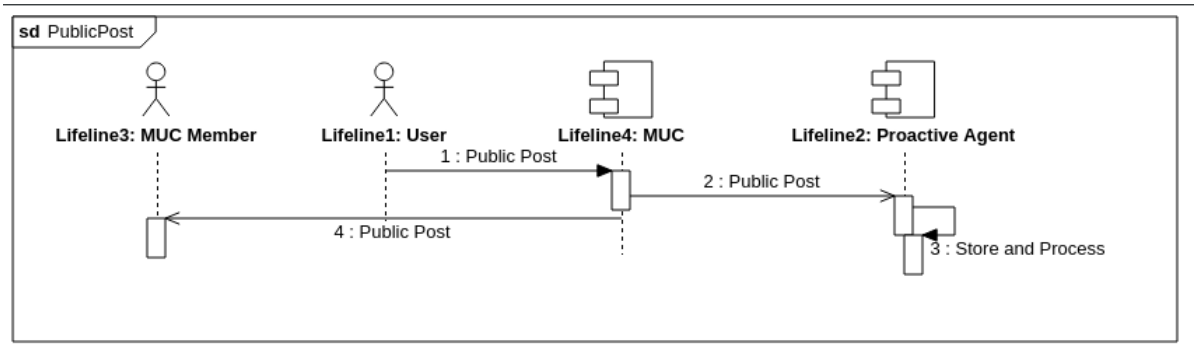


Figure 7: Untagged messages

2.5 Cross-conversation tracking

In Figure 8 it is shown the solution implemented to keep consistent the conversation between a user and Cleopatra agents when he switch from the multi-participant channel to the private one.

In fact, NLP agents track isolated conversation if they occur with different senders. In our case, when a tagged message is received from a user, the Proactive Agent forwards the message to the Tagged NLP. Such request is sent with itself as a sender, and the response is returned back to the multi-participant conversation. The same request is used to trigger the corresponding intent in the Private NLP agent, which is responsible to

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

handle diadic conversations, with the user as sender. In this way, the Private NLP agent tracks the requests of each user in the multi-participant and new private message is processed according the previous history.

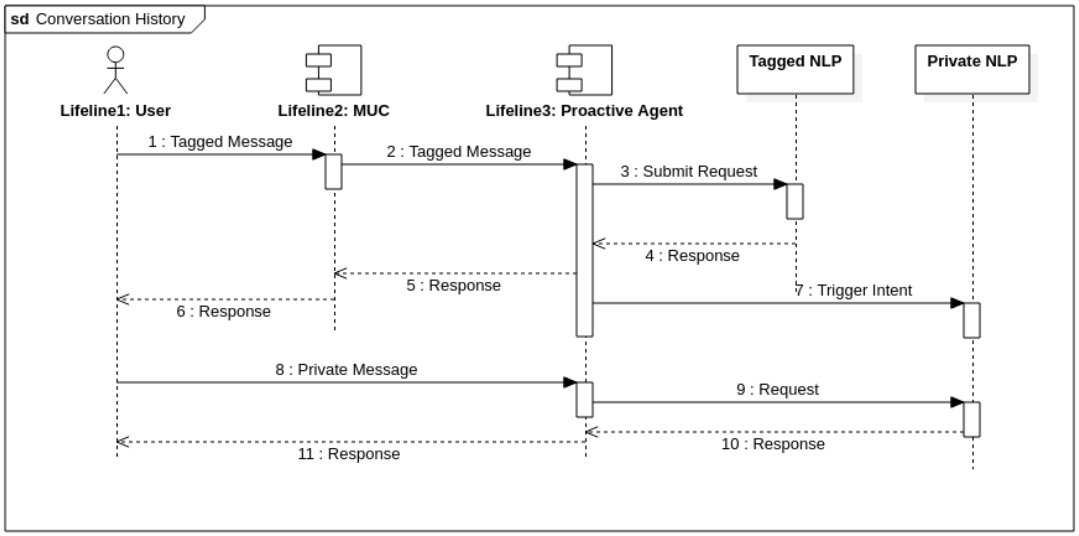


Figure 8: Cross conversations tracking

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

3 Collaborative Models

Based on the communication mechanisms defined before an built upon the software architecture described in deliverable D1.2, and summarized in Figure 4, we defined a minimal set of significant collaborative models which will be experimented in during the project trials.

3.1 Virtual Guide Duplication

This scenario multiplies the capability of traditional guide that must handle all requests of a group of users one after the other dividing the available time between all the participants, when they have individual interest and requirements.

The Cleopatra agent is able to join the multi-users conversation fostering the interaction among participants and allowing them to share the same plot of its story-telling, but if any user is interested in learning more about other aspects of the cultural experience, it can handle a different plot with that user handling parallel diadic conversations. Of course, the user can join the group when it wants or when it is invited by the agent or by other users.

A personalized use mixes with the social one in order to maximize the cultural impact and to diversify and stimulate the experience. Some examples with enable this kind of collaboration follow.

3.2 Context awareness

In order to support such kind of model it needs that the the agent is aware about the each user's context. It is implemented notifying events which allow for identifying relevant situations. Situation can be inferred by an analysis of conversations, but can be also asynchronous respect to the user's interactions.

According to our design choice, data acquired by sensors or event detected by the client application, will use the same transport mechanism used for communication between users and software agents.

Let us imagine that the user follow the story telling of the Cleopatra agent in the multi-participant conversation and the agent controls the user's application showing an image related to its presentation.

When the user decide to change image, the agent is notified about it and:

- it is aware about what the user is looking at
- it can answer to tagged or private message knowing about what is looking at that specific user
- it can send a private message to ask if the user wants additional information switching to a private conversation

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

3.3 Sharing and exploit the individual satisfaction

The social dimension offers the possibility to let users share their positive experience and to detect the critical phases that cause a decrease in interest of majority.

The support of private and multi-user conversations with the software agent in parallel allows for analysing and comparing the personal interest of each users, which can promoted in the multi-users conversation, with the most popular topics in the conversation between human users. Thus it is possible to adjust the story-telling in order to increase the social engagement and participation.

Let us suppose that one or more users of the group do not interact in the multi-participant conversation and have a intensive private conversation on a specific topic, lingering on the same image.

The Cleopatra agent can:

- update the users' satisfaction about the content and eventually recommend that content to the group
- propose semantically related content to the user
- ask the user why he is interested to that content
- can invite the user to recommend that content to the group explaining why it is of interest
- promote the interaction between users with same interest

3.4 Fostering Emergent Behaviours

The Proactive Agent has been designed to pursue the fulfilment of well defined objectives, which aim at leveraging emergent behaviours by the community of human users. As an example let us consider what it is shown in Fig. 4. On left side, the yellow nodes represent user's intents. The user's intention is detected by the NLU capability of the NLP agent on each received message. In a set of pre-defined conversations flows (stories), the NLP agent knows which one is going on with each user. In our toy example, two stories $s1$ and $s2$ are available, which correspond respectively by the black and the blue tiny edges. The dashed arrows represent annotations that link an intent to some relevant cultural contents, which may be presented to the users. We assume here that only one relevant content can be chosen once an intent has been detected. The blue and yellow marked arrows represent two available story-lines, which can be told by the agent to two users who are following respectively conversations $s1$ and $s2$. In this context, the decision problem of planning the story-line for all users consists of finding the best paths in the graph on the right side of Figure 9, composed of those edges that are tagged with the user's conversation $s1$ or $s2$. The two story-lines in the example have different length and share one content, which is presented in a different step of the conversation. Of course, the length of $s1$ and $s2$ may increase, as well as in the same story the intent X could be followed by an intent Y or Z according to the user's input. The decision problem could depend on multiple parameters (e.g., the user's position and time) and may aim at optimizing multiple local or global optima.

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

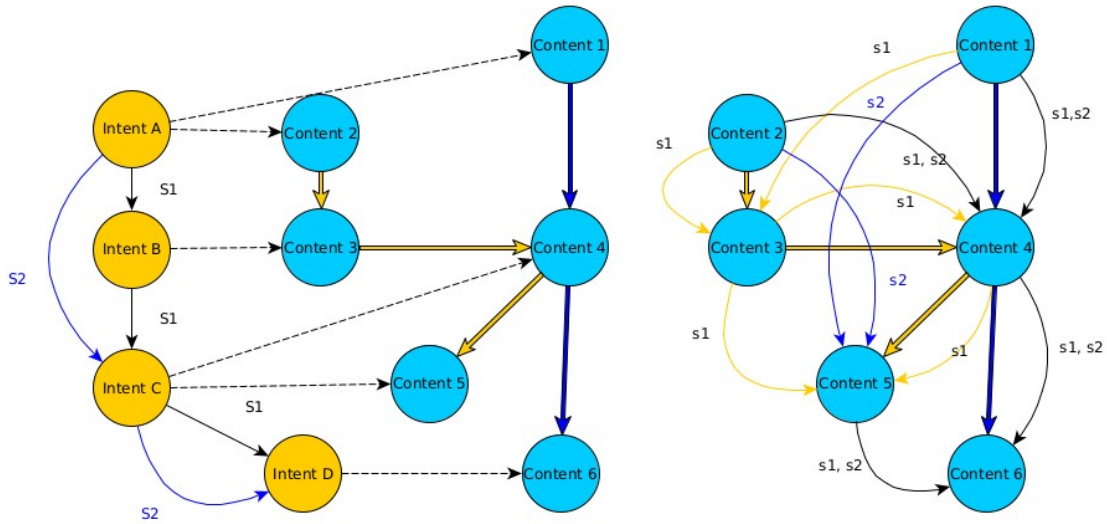


Figure 9: Multiple plots of the agent's story-telling

3.5 Location switch

In the context of the "Diffused Museum", the collaboration among Proactive agents allow for the recommendation to a user about the possibility to switch from a (virtual or physical) location to another during her cultural experience.

The software agent that is moderating the multi-participant conversation and is guiding the user's visit, according to the user's interest, may recommend him to join other location (multi-participant conversations) and to interact with other agents.

This can happen also for a temporary detour from the current story-telling by a diadic private conversation with a software agent that is responsible to present a secondary site connected to the one hosting the user.

3.6 Gamification

The main requirements for the gamification of the proposed cultural experience are based on challenges, which:

- increase the interest of the user toward other related cultural contents
- may, eventually, require or foster social interaction
- use a reward scheme
- should be enjoyable physically and/or virtually

To support this kind of interaction we plan the generation of digital object which may be collected by the user trough a physical or a virtual interaction during her cultural experience. They can be easter egg which can be discovered interacting with other users (e.g.: sharing component of a puzzle).

The usage of NFT (Not Fungible Token) as a kind of crypto-currency, will be investigated, to reward the user with a unique reward that give to her the right to receive a benefit (e.g.: restaurant discounts, gadget, free tickets or free bar).

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

4 Conclusions

In this deliverable we defined the requirements to build collaborative models in the Cleopatra use cases and designed interaction protocols which support the development of collaborative models.

Collaborative models, in the project case studies, will be used to enable the development of six different scenarios which have been presented in Section 3.

Collaborative models will allow both to enhance the users' cultural experience and to provide a support to experts of the cultural domain for improve and extend the agent's intelligent and the presentation of the cultural experience.

The designed interaction will be supported in "D3.1 presentation mechanism" and in "D3.2 P2P platform" by software libraries and will be used in the implementation of project case studies.

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

5 References

[1] Seering, J., Luria, M., Kaufman, G., Hammer, J.: Beyond dyadic interactions: Considering chatbots as community members. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, CHI '19, p. 1–13. Association for Computing Machinery, New York, NY, USA (2019)

[2] Candello, H., Pinhanez, C., Pichiliani, M.C., Guerra, M.A., Gatti de Bayser, M.: Having an animated coffee with a group of chatbots from the 19th century. In: Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems, CHI EA '18, p. 1–4 (2018)

[3] Uthus, D.C., Aha, D.W.: Multiparticipant chat analysis: A survey. Artificial Intelligence 199-200, 106 – 121 (2013)

[4] Tapia, Dante I., et al. "Agents and ambient intelligence: case studies." *Journal of Ambient Intelligence and Humanized Computing* 1.2 (2010): 85-93.

[5] Maria Cerreta, Gaia Daldanise, Paolo Di Lauro and Ludovica La Rocca. Collaborative Decision-Making Processes for Cultural Heritage Enhancement: The Play ReCH Platform (2020). Systems-of-Systems Perspectives and Applications - Design, Modeling, Simulation and Analysis (MS&A), Gaming and Decision Support. Edited by Tien M. Nguyen. DOI: 10.5772/intechopen.92115. ISBN: 978-1-83968-328-2

[6] Deterding S, Khaled R, Nacke LE, Dixon D. Gamification: Toward a definition. In: CHI 2011 Gamification Workshop Proceedings. Vol. 12. Vancouver BC, Canada; 2011

[7] Viola F. Gamification/Pointsfication/Serious Games. 2011 [Online]. Available from: http://www.gameifications.com/gamification-pointsification/

[9] McGonigal J. Reality Is Broken: Why Games Make us Better and How They Can Change the World. New York: Penguin; 2011

[9] Coppock P, Ferri G. Serious Urban Games. From play in the city to play for the city. In: Media and the City. Urbanism, Technology and Communication. Newcastle: Cambridge Scholars Publishing; 2013. p. 120-134

The research leading to these results has received funding by the University of Campania "Luigi Vanvitelli" from VALERE 2019 program.

The research leading to these results has received funding by the University of Campania “Luigi Vanvitelli” from VALERE 2019 program.