A   EMPIRICAL EVALUATION – PROTOCOL

This document includes a detailed description of the protocol followed to conduct the controlled experiment and links to the documents referred to in each of the following sections.

A.1   Tasks performed before the experiment

(1) Screening test

The purpose of this test is to collect information about the participants' prior knowledge regarding the contents of the experiment and to discard any potential participants who may not have the minimum required knowledge.

The minimum requirements to participate in the experiment are the following:

<u>Mandatory</u>
- **Basic knowledge about UML class and object diagrams.** The participant must be able to understand basic UML class diagrams and their corresponding object diagrams and to interpret the meaning of attributes and operations.

<u>Optional</u>
- **Basic knowledge about UML Profiles.** It would be convenient if the participants had some previous knowledge about UML Profiles.
- **Experience using MagicDraw for modeling systems.** If the participants are familiarized with the use of the tool employed in the experiment, they will probably perform better in the sessions.
- **Some knowledge about uncertainty in software models.** If participants have some previous knowledge about uncertainty (measurement, belief), they will understand better the concepts that we introduce in the experiment.

The reason that some knowledge is optional is that we offer some training sessions during the experiment to fill any knowledge gaps that participants may have.

(2) Mandatory readings before the experiment

To ensure that all the participants have the necessary software installed and share the same basic knowledge of the topics required for the experiment, we send them via email the following information the day before the experiment:
- A document explaining some <u>basic concepts about uncertainty</u> (measurement uncertainty, belief uncertainty, subjective logic).
- A <u>document with the instructions on how to install</u> the software needed for the experiment (MagicDraw, our Belief Fusion Plugin, and OBS).
- A license file for MagicDraw.

- The [installation files for our plugin](#).
- An [introductory video](#) about our profile and how to use it in MagicDraw.

Reading of these documents is a mandatory task in order to participate in the experiment. Participants who do not read them will be excluded.

A.2 Experiment

(1) Session 1 (50 minutes)

(a) Introduction to uncertainty (20 minutes)

Following a [deck of slides](#), we give a brief introduction (15 min) about uncertainty in general, Belief Uncertainty, Subjective Logic, and the datatype SBoolean, used to express opinions using Subjective Logic in UML diagrams.

After the presentation, the participants are allowed to ask questions about any of the concepts introduced.

(b) Introduction to the *Belief Uncertainty UML Profile (20 minutes)*

Using a [video](#), we explain how to use the Belief Uncertainty UML Profile with MagicDraw, using the example of the [Smart House](#).

In this presentation, we introduce the [Belief Uncertainty UML Profile](#), its main components, the meaning of assigning an opinion to different parts of an object model (object, link, attribute), and how to use the UML profile in MagicDraw.

(c) Questionnaire 1 (10 minutes)

This questionnaire assesses the participants' level of understanding of the concepts introduced in the previous sections. This ensures that the training sessions were effective and helps to justify any potential comprehension issues in further sessions.

(2) Session 2 (40 minutes)

(a) Permission to record their screens

To later analyze the performance and evaluate the usability of our methodology, we ask participants for permission to record their screens. This way, we will be able to tell which are the most common mistakes and reflect on how to improve our proposal.

(b) Exercise: Find the Ark of the Covenant (30 minutes)

In this [exercise](#), the participants are asked to assign opinions to different elements

in the object models following a given role. The roles are randomly assigned, forming groups of three people.

Each of the roles must give an opinion about three different elements of the model: a link, an object, and an attribute. This helps us evaluate if they can assign the opinions to each element, and if they understood the meaning of the assignment.

The participants can ask questions about the exercise statement, but not about how to perform it. To help them, we gathered the instructions on how to assign an opinion to an element in a [cheat sheet](), so that they did not have to watch the provided video multiple times during the experiment.

The participants must record their screens during this exercise.

(c) Questionnaire 2 (10 minutes)

When all the participants complete the previous exercise, they are required to fill out a questionnaire about their impressions regarding the usability and expressiveness of the approach. Additionally, we request them to provide a screenshot of the object model with their opinions assigned.

(d) Permission to record audio

At the end of the above questionnaire, we ask for their consent to record their discussions live during the next session. We will analyze these audios afterward to reflect on how they reach their conclusions with and without the fusion operators.

(3) Session 3 (90 minutes)

(a) Separate the participants into groups

The participants are separated by groups in the room according to the role assignments in section 2b. Each of the groups will use only one laptop and a recording device that will save the conversations for later analysis.

(b) Exercise: Should we dig in Mount Nebo? - No fusion operators (30 minutes)

In this [exercise](), the participants have to assign an opinion to the existence of the ruins of the Lost Ark in Mount Nebo. Using only one laptop, they will assign their opinions to the corresponding object. Then, they will have to reach an agreement deciding whether they should dig in that place or not.

The participants will be required to record their laptops screens during this session. Their discussions will be recorded.

(c) Questionnaire 3 (15 minutes)

After the previous exercise, the participants are required to fill out a questionnaire that asks about the decision-making process: where the decision was satisfactory for everyone, the obstacles for reaching the agreement, the process they followed, etc.

(d) Introduction to the fusion operators (15 minutes)

Using some [slides,](#) we introduce the five fusion operators using examples. After the presentation, participants can ask questions about the operators to ensure their understanding.

(e) Exercise: Should we dig in Mount Nebo? - Using fusion operators (15 minutes)

After introducing the fusion operators, the participants are asked to choose one that fits their current situation, depending on their intentions. Then, they are asked to use the fusion plugin in MagicDraw to combine their opinions and reflect on the results.

With the information provided by the fusion operators, they have to decide if they will keep the decision to dig or not in Mount Nebo to find the Lost Ark.

The participants will be required to record their laptop screens during this session. Their discussions will be recorded.

(f) Questionnaire 4 (15 minutes)

In this questionnaire, they are asked about the decision-making process using the fusion operators: the operator they chose and why, whether they reached an agreement or not, how difficult the process was with the fusion operators, and whether everyone was satisfied with the final decision or not.

Finally, some questions were included about their opinions on the proposal in general and if they wanted to make any suggestions to improve it.

A.3 Post-experiment

After the questionnaire is completed, the participants are asked to upload the videos recorded during the experiment to a shared folder.

B PROTOCOL IMPLEMENTATION

This section includes the questionnaires (questions and responses) used to implement the protocol described in the previous section.

B.1 Session 0 – **Screening test**

B.2 Session 1 – **Questionnaire 1 (Basic questions)**

B.3 Session 2 – **Questionnaire 2**

B.4 Session 3A – **Questionnaire 3**

B.5 Session 3B – **Questionnaire 4 and final questions**