UNIVERSITÀ DEGLI STUDI DI GENOVA

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DEPARTMENT OF COMPUTER SCIENCE AND TECHNOLOGY,
BIOENGINEERING, ROBOTICS AND SYSTEM ENGINEERING

SOCIAL ROBOTICS

Second Assignment

Interaction with social robots

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1 Application description

The application was developed using **Choregraphe** version 2.5.10.7, with the aim of enabling the robot Pepper to perform a series of specific actions, such as approaching a person described by the interlocutor, retrieving a Lego block from him and then delivering it to a third person.
All these actions are performed in two different environments: a laboratory room and a corridor.
In order to realize it, we made use of custom **Dialog boxes**, namely *Target*, *Bring* and *Game*, to provide the robot of behavioural and speech responses. Meanwhile, to direct the robot's movements on the Cartesian coordinates and to guide it towards the targeted people, we used two **Move To** blocks, adapting the code to integrate linear and angular control appropriate to our situation. Additionally, we created three different **timelines**, in order to specify new actions, such as waving and opening or closing the robot's hands to grab and bring an object:

- **Greetings** allows Pepper to lift and move its left arm to greet the human it is interacting with and raise the right hand to prepare to shake that of a human;
- **Retrieve** allows Pepper to lift its right arm and rotate the wrist to retrieve the object from the human agent;
- **Deliver** allows Pepper to open its hand to deliver the object.

Due to the difficulties encountered by Pepper in holding objects in its hand, a **Stiffness** block was necessary to ensure that the arm remains lifted and steady during the delivery of the object, while realizing the video. It is important to note that this block was useful only when running the program on the real robot and that we had to change the process accordingly, during the simulation this behaviour cannot be observed.
Finally, in order to achieve a simulation of *mixed interaction* we used two **Say** boxes, so that the robot could initiate a conversation without being prompted beforehand, while **Delays** were used to facilitate the interactions.

2 Perceived intelligence

To maximize the perceived intelligence of the robot, that is, to give the impression of naturalness and interaction similar to that with a human being, we focused on several aspects:

- **Multiple speech acts**;
- **Mixed initiative dialogue**;
- **Motor correlates of speech and non-verbal communication**;

The *first requirement* was met when Pepper was able to deduct the implicature present in an assertive statement. We refer to when the first speaker, Simone, states how exhausted he is and Pepper, understanding the hidden meaning of the phrase, offers its help to alleviate the stress from him.
The *second point* is evidently satisfied, this can be observed throughout the three different dialogues: a particular example can be extracted from the first one, which is initiated by the human agent and continued by Pepper by asking for his name, since he did not introduce himself, or when the robot asks the second interlocutor, Manuel, whom to look for the delivery of the Lego block.
For the *third aspect*, we added deictic gestures when addressing the different interlocutors, such as greeting by waiving the left hand and by raising the right one.
Additionally, we tried as much as possible to ensure that Pepper's gaze was directed towards the interlocutor, as this has a significant influence in collaborative tasks such as, in our case, picking up and carrying a Lego block to complete a construction. Only in one case this was not possible: when Pepper enters the corridor and delivers the Lego block to the third interlocutor, Matteo. In fact, Pepper's gaze is directed elsewhere, because it detected the face of the person filming the scene.

3 Statistical analysis

To conduct the statistical analysis, we collected data from the 40 participants of the Godspeed questionnaire in an Excel spreadsheet. We decided to compare two of the five categories of the questionnaire, namely **likeability** and **perceived intelligence**, among the same 40 users by using a paired T-test. Note that this test can only be used in the presence of normal distributions, which can be checked via the **Shapiro-Wilk** Test to assess the normality of the data. This step was not necessary in our case, in accordance with the *central limit theorem*, which states that after a number exceeding 30 samples, we can consider the distribution

to be normal. We formulated the following **null hypothesis**: *According to the votes given by the people who answered the questionnaire, no significant difference in the evaluation of likeability and perceived intelligence of the robot, based on the proposed video, will be observed* and a 5% significance level was chosen.
We calculated the averages, standard deviations and variances of the total scores from the relative tables, obtaining the following results:

Summary table			
Questionnaire categories	Average	Standard deviation	Variance
Likeability	21.625	3.183994427	10.13782051
Perceived intelligence	19.275	2.631052241	6.922435897

Finally, we uploaded the data on Stats Kingdom:

- p-value $p = 5.793 \times 10^{-12}$, which is a measure of the probability that the observed difference in means would have occurred by chance if the null hypothesis were true;
- t-value $t = 7.3258$, which is a statistic measurement of the degree of difference relative to the variation in our sample data;

Since the **p-value** is less than the significance threshold of 0.05, **we reject the null hypothesis**, or, more precisely: the error committed in rejecting the null hypothesis is equal to the p-value. We can, therefore, accept the **alternative hypothesis**, which states that *there is a significant difference in the evaluation of likeability and perceived intelligence of the robot Pepper for the studied group*.

4 Division of work for the assignment

The work relative to the assignment was evenly divided among the four team members. We all decided together on the actions and behaviours we wanted to implement via Choregraphe and the work was divided as it is here listed.
Simone Borelli took care of:

- Structuring and implementing the dialogues related to Pepper and the three interlocutors to cover as many points as possible regarding perceived intelligence;
- Writing all sections of this report;

Matteo Cappellini was responsible for:

- The part of non-verbal communication, by developing the **Retrieve** and **Deliver** timelines, debugging them and fixing the problem we encountered when Pepper let go of the Lego block after retrieving it;
- Editing the questionnaire video;

Manuel Delucchi took care of:

- Assisted in debugging the code in Choreograph, with a primary focus on refining Pepper's movement. Resolved challenges related to reaching designated spots and ensuring optimal engagement with interlocutors at the correct distance;
- Performing the statistical analysis;

Matteo Forni was responsible for:

- The first part of non-verbal communication, by developing the **Greetings** timeline and by designing the initial structure of the program;
- Filming the videos and developing the questionnaire.