Human-Centered Interaction in Robotics

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Homework 05

Task 1. Designing a Human-Robot Interaction Experiment (45%)

Suppose that you are developing a scenario where the Atlas robot should assist a plumber by bringing necessary tools and objects when requested. Let's say, you have developed several ways in which the robot can handover an object to the plumber. Now, you would like to evaluate these by conducting an empirical study with experienced plumbers. (You can watch this video for inspiration: https://www.youtube.com/watch?v=-e1_QhJ1EhQ)

  a) Define at least one research question that you would like to investigate in the context of human-robot interaction in the above scenario.
  b) Identify the constructs involved in this research question(s).
  c) Formulate at least one hypothesis based on the research question(s) and the identified constructs.
  d) How would you operationalise the constructs in the above hypotheses?
  e) How would you design your study (context, conditions, allocation of subjects)? Justify your study design.
  f) What would your null hypothesis look like, for each of the hypotheses that you formulated above?

Note: We have checked ChatGPT responses. These are not precise and do not fulfil the characteristics of good research questions and hypotheses as discussed in Sections 2 and 3 of the following paper:

Guy Hoffman and Xuan Zhao. 2020. A Primer for Conducting Experiments in Human Robot Interaction ACM Trans. Hum. Robot Interact . 10, 1, Article 6 (October 2020), 31 pages https://doi.org/10.1145/3412374

Task 2. Understanding Power Analysis for t-tests (25%)

With the help of *statsmodels*[1] library, create plots showing the relationship between alpha level, effect size, sample size and statistical power for (i) two independent sample t-test, and (ii) paired sample t-test. Explain your observations based on the plots.

Note: Take a look at the Python classes:
statsmodels.stats.power.TTestPower and *statsmodels.stats.power.TTestIndPower.*

Submission: Insert the plots and explanations in the PDF and submit the Python code that you used to create the plots as a separate file.

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[1] https://www.statsmodels.org/dev/stats.html#power-and-sample-size-calculations

Task 3. Performing statistical tests (30%)

A robotics company has created a new social companion robot for elderly persons. Since the robot is designed for elderly men and women who are living alone, it has to appeal to both demographic groups equally. Before the company mass-produces the robot, it wants to make sure that the robot appeals equally to both elderly men and women.

More specifically, the company wants to know whether men and women engage with the robot in the same way.

To achieve this, 20 elderly men and 20 elderly women were recruited and asked to interact with the robot in a home setting. The participants were then asked to fill in a questionnaire that measures their engagement with the robot. An overall engagement score was computed based on the responses to the questionnaire. The scores for each person is provided in the file 'advertising_agency_engagement.csv'.

a) Plot appropriate graphs and comment on outliers, if any.
b) Determine whether the data is normally distributed.
c) Mention the statistical test that you would use to validate the hypothesis given below. Justify your answer.
    Hypothesis H1: Elderly men and elderly women engage differently with the robot.
d) Conduct the statistical test and report the results.
e) Explain your conclusion about the hypothesis.

Note: Please upload your source code, preferably in the form of a Jupyter notebook.

Feedback:

Please answer the following:
1. How much time did you spend on doing this sheet per person? Anonymize your answer!
2. Was this sheet too easy / easy / ok / hard / too hard?
3. What additional resources (blogs, papers, books, tutorials, etc.) did you use? Please provide links or references.
4. Did you face any issues while solving this sheet?

Submission Procedure:

Upload the PDF of your solutions and the relevant source code files in LEA as a single Zip archive. For the naming convention for your submission, please follow the instructions under Course Rules in LEA.