Enhancing Understanding in Receiver Operating Characteristic (ROC) Curve Analysis: An Investigation into the Impact of Interactive Teaching Methods

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1. Background

- AI-related degree programs are on the rise [4]. The need to efficiently and effectively teach machine learning courses is increasing.
- Students need to understand how to evaluate a machine learning algorithm based on its performance. ROC (Receiver Operating Characteristic) curve analysis is a key concept in evaluating machine learning algorithms.
- Recent years have seen an increase in the use of ROC graphs in the machine learning community. This increase is due in part to the realization that simple classification accuracy is often a poor metric for measuring performance [2].
- Interactive visualizations appear promising for enhancing the understanding of computer science concepts, particularly when learners actively engage with them.

2. Objective

How do interactive receiver operating characteristics (ROC) curve visualizations compare with traditional static visualizations in terms of students' understanding of ROC analysis concepts?

3. Methodology

Two research methods were selected to conduct the study:

- **Experiment:** An experiment was conducted involving two groups: a control group and an experimental group. The first one has access to a Jupyter Notebook with static visualisations. The second group has access to a Jupyter Notebook with interactive visualisations. Both groups consist of first-year students, enrolled in the CS Bachelor's program at TU Delft and had no previous knowledge of ROC curve analysis.
- **Survey:** A survey was created to test students' understanding of the ROC curve analysis and understand their motivation after completing the material. The survey's responses were analysed to detect if the interactivity improved the student's ability to comprehend the material on ROC. The motivation is measured through the Reduced Instructional Materials Motivation Survey (RIMMS).

Both digital notebooks contain the same material similar to the ML course CSE2510. The only difference is in the visualisations.

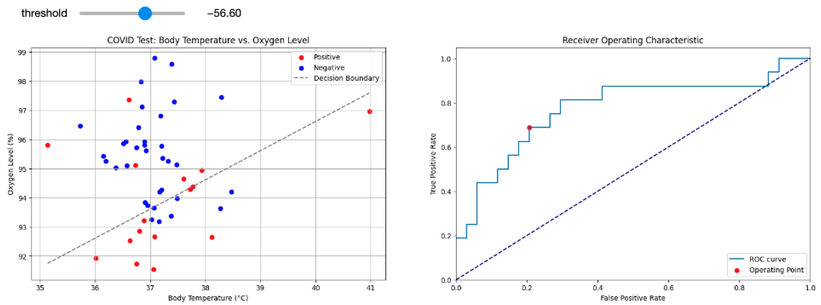

Figure 1. First interactive visualisation present in the notebooks

4. Results

- The analysis of pre-test and post-test scores reveals a significant improvement in participant understanding across both visualisations.
- The mean score for the experimental group is 6.4 points from 9 possible points and the standard deviation is 1.77. The mean for the control group is 5.7 points and the standard deviation is 1.49.
- There is not a statistically significant difference in the knowledge gain between the two groups. (p = 0.403)
- Both groups register good motivation scores after completing the notebooks, with the control group (static visualisation) having better results.

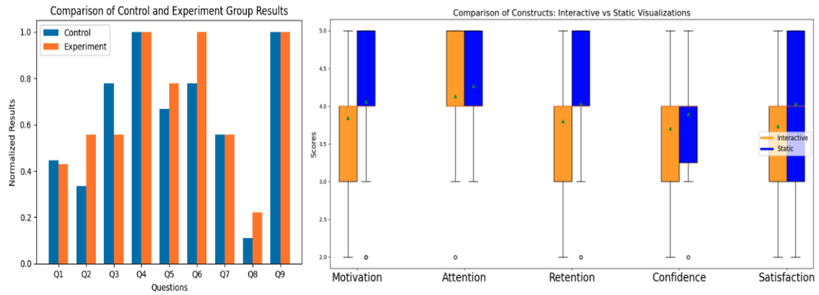

Figure 2. Results after survey. Leftmost plot shows the normalised gain for both groups, whereas the rightmost shows the attention, retention, confidence, satisfaction and overall motivation.

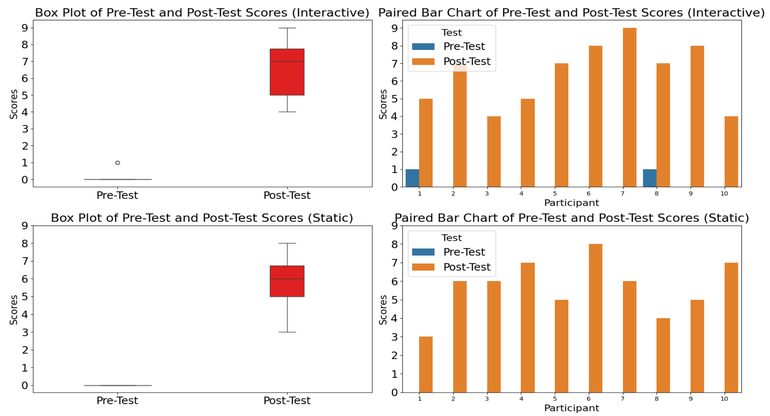

Figure 3. Pre- and Post-tests scores for both groups

5. Future Work

- Recreate the experiment with a larger sample size to increase the robustness of the results and use more learning objectives, which are placed higher in Bloom's Taxonomy.
- Investigation of interactive visualisations on other complex machine learning concepts such as Principle Component Analysis or Gradient Descent.

6. Takeaways

- This study emphasises the potential of interactive visualisations to enhance the learning experience for ROC curve.
- Interactive teaching methods hold promise for making complex concepts like ROC analysis more accessible and engaging for students.

References

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