University of Waterloo
Department of Electrical and Computer Engineering
ECE 603 – Statistical Signal Processing
Fall, 2024

Final Project

Objective

This project aims to develop students' skills in critically analyzing, reproducing, and extending published research within the field of statistical signal processing. Working in teams of two, students will be assigned a research paper relevant to signal estimation, prediction, or detection. Each team will:

1. Thoroughly review the assigned paper to understand its methods, assumptions, and results.
2. Reproduce the paper's primary results, providing a detailed explanation of their approach, challenges faced, and how they addressed them.
3. Explore a new dimension by extending the original research in a meaningful way, such as applying it to a new dataset, modifying assumptions, or enhancing the model.

Project Goals

Deepen Understanding: Through reading and reproducing research, students will gain insights into core statistical signal processing techniques and their applications.

Develop Technical Skills: Students will learn to design, implement, and troubleshoot algorithms to match the original research findings.

Foster Innovation: Extending the research encourages students to think critically and creatively, applying their knowledge to new scenarios or constraints.

Promote Reproducibility: By requiring clear, documented code, students will learn the principles of reproducible research.

Project Deliverables

Written Report (10-15 pages) detailing the project background, reproduction process, and extended work.

Code Repository (hosted on GitHub or a similar platform) to demonstrate reproducibility, with clear instructions for replicating both the original results and the extended work.

Presentation (10-25 minutes) to summarize key findings and discuss the extension's impact.

Suggestions for Extending Research Papers

Here are some directions in which students could extend their assigned papers:

1. **Higher-Dimensional Analysis:** If the original paper deals with low-dimensional signals, students could attempt to extend the methodology to higher-dimensional datasets or introduce complexity (e.g., working with 3D signal arrays).

2. **Different Application Domains:** Students can apply the techniques to new datasets from a different domain. For example, if the paper's methods are applied to audio signals, students might explore applications in image processing, biomedical signals, or financial data.

3. **Algorithm Enhancements:** Students could try modifying or optimizing parts of the algorithm to improve computational efficiency, reduce memory usage, or handle noise more effectively.

4. **Exploring Robustness and Limitations:** Students could investigate the robustness of the approach by testing it on noisy, incomplete, or real-world datasets. This could involve adding noise, introducing missing values, or creating synthetic data with varying properties.

5. **Comparative Study with Related Methods:** Students could compare the original method with alternative approaches or state-of-the-art techniques, discussing the trade-offs and performance differences.

6. **Alternative Evaluation Metrics:** If the paper primarily uses one performance metric, students could evaluate the results using different metrics to provide a more comprehensive assessment.

Evaluation Criteria

Completeness and Accuracy of Reproduction (40%): Successful replication of the core results with a clear description of the methodology. Explanation of any discrepancies and their potential causes.

Quality of Extension (30%): Innovation and relevance of the proposed extension. Depth of analysis, demonstrating a comprehensive understanding of the problem and thoughtful exploration.

Documentation and Code Clarity (15%): Well-documented code repository that enables straightforward reproduction. Clear, organized report with sufficient detail in methodology, experiments, and results.

Presentation (15%): Clarity and conciseness of key points. Demonstrate a grasp of both the original research and the extension.