Introduction
This CPD project uses software engineering and machine learning techniques to enhance speech intelligibility in noisy environments. As an software engineer interested in IoT and embedded systems, this project aligns with my passion for integrating hardware and software to solve real-world problems.

Project Objective
To develop a system that can effectively filter out background noise from audio streams to improving speech clarity using machine learning algorithms and signal processing techniques.

Learning Goals and Outcomes
- **Learning Goal 1:** Improve Python programming skills.
- **Outcome:** Efficient use of Python for audio processing and machine learning implementation.

- **Learning Goal 2:** Master data preprocessing in machine learning, focusing on audio data.
- **Outcome:** Apply various preprocessing methods like normalization, denoising, and feature extraction specifically tailored for audio signals.

- **Learning Goal 3:** Gain proficiency in machine learning.
- **Outcome:** Implement and optimize machine learning models for noise recognition and suppression, focusing on Convolutional Neural Networks and Support Vector Machines.

Timeline and Weekly Breakdown
- **Week 1:** Set up the project environment, including installations and data collection from diverse environments.
- **Week 2:** Begin audio data preprocessing using Python; apply basic filtering techniques.
- **Week 3:** Implement advanced data preprocessing techniques and feature extraction.
- **Week 4:** Explore and implement machine learning algorithms for noise cancellation.
- **Week 5:** Test and refine the machine learning models with a separate validation dataset.
- **Week 6:** Integrate the trained models into a hardware prototype for real-world testing and prepare the final project documentation and presentation.

Measures of Success
- **Project Success:**
  - Effective noise reduction is measured by improved signal-to-noise ratio (SNR) and user feedback.
  - Achieve at least 60% accuracy on the validation dataset.
  - Comprehensive documentation covering system design, algorithm choices, and training processes.

- **Learning Success:**
  - **Learning Outcome 1:** Ability to verbally explain and technically implement the steps of data preprocessing and machine learning.
  - **Learning Outcome 2:** Describe and implement two machine learning models with a detailed understanding of their application in audio processing.
  - **Learning Outcome 3:** Complete a project that applies learned techniques to preprocess audio data and implement noise suppression.
  - **Learning Outcome 4:** Perform a comparative analysis of the methods and models used, including performance metrics like accuracy, precision, recall, and F1 scores.
- Off-ramps and Risk Management
- Interim Checkpoints:
  - **End of Week 2:** Reassess data collection and preprocessing effectiveness.
  - **End of Week 3:** Evaluate feature extraction and readiness for machine learning.
  - **End of Week 4:** Review initial model training results and make necessary adjustments.
- Risk Factors:

- Data Quality and Quantity: Ensure robust data collection and consider alternative sources if needed.
- Time Management: Adjust weekly goals based on actual progress to stay on track.
- Learning Complexity: Provide for additional learning resources if machine learning concepts prove challenging.

Motivation and Link to Software Engineering

This project supports my career goal of becoming a skilled IoT software engineer, capable of integrating software solutions with hardware components to solve complex problems like audio noise cancellation.

Resources

- https://asmp-eurasipjournals.springeropen.com/articles/10.1186/s13636-021-00204-9
- https://towardsdatascience.com/background-noise-removal-traditional-vs-aialgorithms-9e7ec5776173
- https://towardsdatascience.com/acoustic-noise-cancellation-by-machine-learning-4144af497661
- https://krisp.ai/blog/active-noise-cancellation-technology-vs-ai-based-noise-cancellationalgorithms/
- https://medium.com/@tnsaeasefa08/how-to-use-python-for-audio-processing-30eb6c1de9c6
- https://www.it-jim.com/blog/audio-processing-basics-in-python/
- https://github.com/markostam/active-noise-cancellation
- https://github.com/loehnertz/rattlesnake