Remote Machine Learning for Cyberphysical Systems

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1. Overview

With the rise in popularity of data analytics and machine learning there is a surge of students eager to learn about these topics. However, most existing courses and learning material are either completely theoretical or at best use an impractical oversimpified system as a toy example. Therefore, the motivation for this lab is to help educate the students of RWTH on how these methods are applied to real practical applications. Furthermore, the well explained and instructed learning material offered here as well as its availability online promotes remote self-learning for students. An overview of the experiments and the learning material therein is provided in table 1.

Experiments	**Data Collection**	**Preprocessing**	**Learning Algorithm**
Discrete Localization	prepared dataset	centering, scaling, thresholding	$k$means, kNN
Blind Source Separation	artificially generated	centering, whitening	PCA, ICA

Table 1: Overview of methods and experiments

2. Discrete Localization

In this experiment, acoustic discrete localization is of interest, as they can achieve high accuracy, with low power consumption and infrastructure costs. The room impulse response may be used to capture a unique signature depending on the source and the receiver locations. This will be mainly done by dividing the room into smaller areas and identifying the area the new recording is most likely to belong to. For this purpose we introduce two techniques for localization named k-nearest-neighbor and k-means clustering as well as the necessary preprocessing steps.

3. Blind Source Separation

In this experiment we look at blind source separation in the context of the cocktail party problem. This describes the human ability to extract and recover a desired voice in an environment with multiple speakers. We cover the required preprocessing steps and fundamentals of PCA and ICA

and learn how to implement the these algorithm for separating speech signals.

4. Remote Learning

During the production of the learning materials there has been a strong emphasis in allowing the student to learn independently without needing a lab or a supervisor. For this purpose, the necessary datasets are either provided or artificially generated by the student. Furthermore, the scripts are prepared in a MATLAB Live format where the student is supposed to complete the critical parts. This allows us to provide further instructions and comments to promote self-learning. The MATLAB Live scripts are complemented by a set of handbook which explains the concepts in more detail, README files as well as a FAQ and troubleshooting document. As part of the remote learning we have made all the produced material available on the ISEK homepage (at `http://www.isek.rwth-aachen.de/`) accessible to all RWTH students via their GitLab accounts.

5. Maintenance and Upkeep

We would like to clarify that while the developed material is mature and complete, we will ensure it is properly maintained and updated where necessary.