Aprenentatge Automàtic per a Xarxes (ML4Net)

Seminar 4 - Problem statement

May 7, 2025

Abstract

On this occasion, we will retake the Wi-Fi performance prediction problem from Seminar 1. However, this time you will have to address it using Neural Networks (NNs), which are much more complex than linear regressions. The dataset that you are going to use in this seminar (`dataset_Seminar4.zip`) contains Wi-Fi measurements taken from real residential networks during one month.[1] The provided dataset is divided into train (`train_data.csv`) and test (`test_data.csv`) samples. Both files contain the following features and labels:

- [Feature] **LocationNumber:** Represents the zone number where data was collected (up to 35).
- [Feature] **RSSI:** The signal strength at the given location.
- [Feature] **TxLinkSpeed:** Transmission link speed (downlink, AP to STA).
- [Feature] **RxLinkSpeed:** Transmission link speed (uplink, STA to AP).
- [Feature] **MainAPConnect:** A binary feature that indicates whether the client is connected to the main AP (1) or an extender (0).
- [Feature] **TxThroughput:** The actual throughput achieved.
- [Feature] **AvgPingLatency:** The average latency experienced (measured using ping tests to a server).

1 Part I: Data preparation & analysis

Your job in this part of the seminar is to visualize and understand the data that you are going to use to train and evaluate your neural network. Complete the following tasks:

1. Describe the statistics behind the main parameters of the dataset. For that, make use of the plots that you consider.

2. Perform a correlation analysis between the main features in the dataset and the performance metrics (throughput and delay).

[1] Original dataset: `https://ieee-dataport.org/documents/best-wi-fi-zone-dataset-home-office`

2 Part II: FNN-based performance predictor

Now, you will design and implement a feedforward neural network (FNN) that predicts the performance of the Wi-Fi network (throughput and latency) based on the features you consider. The implementation of a neural network involves multiple considerations, so we ask you to complete the following tasks:

1. **Feature selection:** select the features that you think will be most appropriate to predict Wi-Fi performance.

2. **Data preparation:** apply the necessary data transformation techniques for your data (e.g., normalization, encoding).

3. **FNN architecture design:** design your FNN and try to justify your choices (number of layers, input/output layers, activations, loss function, optimizer, regularization, etc.) according to the problem and data at hand.
   Note: You can design a multi-output FNN that predicts both the throughput and the delay, or define two different FNNs (with the same architecture or not) to predict the two metrics separately.

4. **Train your FNN:** use the training data to train your FNN. Describe your training approach (epochs, batches, validation) and show the training process (e.g., validation loss per epoch).

5. **Evaluate your FNN:** evaluate your solution using the test data and report the results.