Chair of Communication Networks
TUM Department of Electrical and Computer Engineering
Technical University of Munich

Master's Thesis

Graph-network-based RSSI fingerprinting for localization

Indoor positioning is a crucial feature for diverse industrial use cases, as it allows for improved monitoring and task automation, thus enhancing production efficiency. Nonetheless, inexpensive positioning deployments based on signal strength measurements struggle to provide good localization accuracy, as these measurements are usually highly variant.

Fingerprinting based on received signal strength indicators (RSSI) has been proposed as a promising approach to mitigate the high variability and lead to relatively high positioning accuracy while keeping deployment costs low. Nonetheless, using RSSI fingerprinting for accurate positioning entails mapping large and noisy vectors of RSSI measurements to specific points in space, which is a challenging task.

Several techniques have been evaluated in the state of the art to perform this mapping: distance estimation followed by trilateration, k-nearest neighbors averaging, radiomap interpolation and error minimization, and, in recent years, also neural networks. By training neural networks with sufficient amounts of accurate data, we can abstract away the complexity of the mapping and still achieve accurate positioning.

Nonetheless, as in other applications, it has been observed that neural networks often struggle at generalizing data beyond those close to the training set, and their complete lack of knowledge about the underlying physical phenomena may result in obviously wrong results that are difficult to prevent with simply more training.

Motivated by these and other related facts, in recent years the concept of graph-network- based learning has emerged. As opposed to neural networks, graph networks use graphs to represent all inputs and outputs of the learning process and apply modified versions of common training approaches to convert input graphs into output graphs. The intention behind this procedure is that graphs themselves can be defined in such a way to model our a priori knowledge about the inputs and outputs.

In this thesis, we will investigate the application of graph-network-based machine learning to RSSI fingerprinting for localization, with the intention of incorporating radio propagation and environment models into the learning process. The results will be compared against other state-of-the-art ML approaches to conclude whether graph networks can help in producing more accurate positioning from the same training data.

Prerequisites

- Python/C++/Matlab
- Machine Learning basics
- Wireless communication basics
- Mmathematical and analytical skills

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