Machine Learning-based Resource Allocation for 5G Systems

Introduction

Fifth generation (5G) mobile communication systems are envisioned to provide seamless connectivity to all users present in the system, all the time. Traditionally, the system relies on channel state information (CSI) acquisition for serving the user terminals. However, with high user density, inclusive of high-mobility users, CSI acquisition incurs significant system overhead, which adversely affects the system performance. With the dense outdoor deployment proposed for 5G systems [1], the user position estimates can be obtained accurately and can be used to serve the user terminals, instead of using their CSI. Machine learning can be utilized for this purpose: using terminals' positions as input, the machine learning algorithm can be used to predict the appropriate system resources that should be allocated for serving the user terminals in the system. This forms the basis of the idea for learning-based resource allocation for 5G systems.

Thesis Outline

The thesis will focus on implementing various machine learning algorithms to compare the system performance with that obtained from CSI-based resource allocation scheme. Primarily, the problem is designed to be suitable for supervised learning algorithms. Therefore, learning algorithms such as K-nearest neighbor (KNN) [2], support vector machines (SVMs) [3], random forests [4], and neural networks [5] will be implemented as the learning models (other learning algorithms can also be implemented). The datasets for training and testing are generated using a ray-tracer based simulator, with the exhaustive search performed on all generated samples (which is a quite complex computation process). These datasets will be provided upfront for training the different learning models. The performance of different learning algorithms will be compared in terms of prediction accuracy, precision, etc., along with the performance comparison in terms of system goodput. It is expected that the resource allocation based on the learning algorithms will provide system goodput quite close to the CSI-based scheme, with much less computational complexity as experienced in the traditional system set up.

Eligibility Requirements

The student is expected to have good knowledge of different python packages, including scikit-learn, and should be proficient in programming on python, MATLAB and tensorflow. Moreover, he/she should be familiar with working in Linux environment. Some knowledge about the basic concepts of wireless communication systems will also be needed.

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References:

[1] V. Venkatasubramanian, M. Hesse, P. Marsch, and M. Maternia, "On the Performance Gain of Flexible UL/DL TDD with Centralized and Decentralized Resource Allocation in Dense 5G Deployments". In 2014 IEEE 25th Annual International Symposium on Personal, Indoor, and Mobile Radio Communication (PIMRC), pages 1840-1845, Sept 2014.

[2] https://en.wikipedia.org/wiki/K-nearest_neighbors_algorithm#cite_note-1

[3] http://web.mit.edu/6.034/wwwbob/svm-notes-long-08.pdf

[4] Breiman, Leo. "Random forests." *Machine learning* 45.1 (2001): 5-32.

[5] http://neuralnetworksanddeeplearning.com/index.html