Application of Machine Learning to Resource Allocation in Wireless Communications

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Introduction

- Next-generation wireless networks are expected to support extremely high data rates.
- New wireless radio technology applications needed.
- Assisting the radio in intelligent adaptation and decision-making.
- Machine learning is one of the most promising artificial intelligence tools in this case.

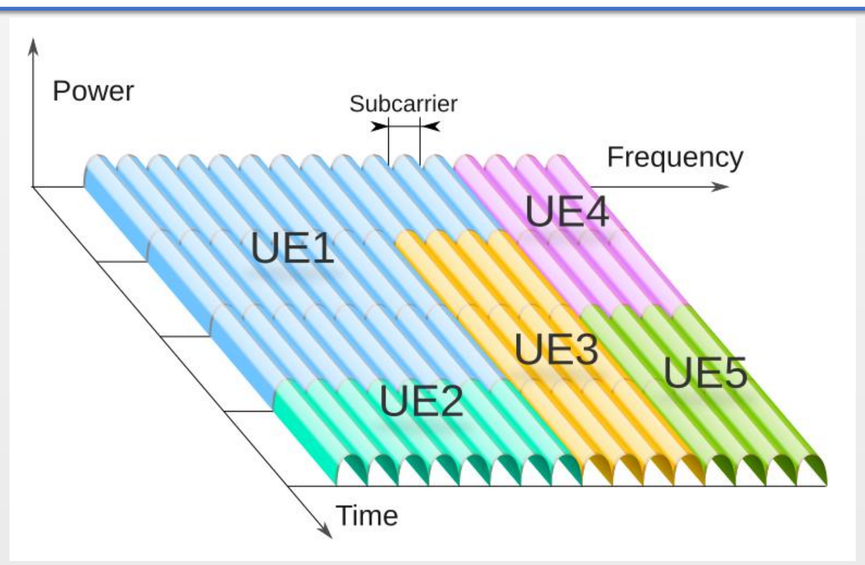
A machine learning approach have been studied for solving resource allocation problems in wireless communications.

Problem Description

The environment consists:

- A base station
- An arbitrary number of users
- A limited radio spectrum being managed with OFDMA

Distribution of resource blocks using a machine learning method and a conventional algorithm is the main concern.



Optimal Allocation Using Conventional Means

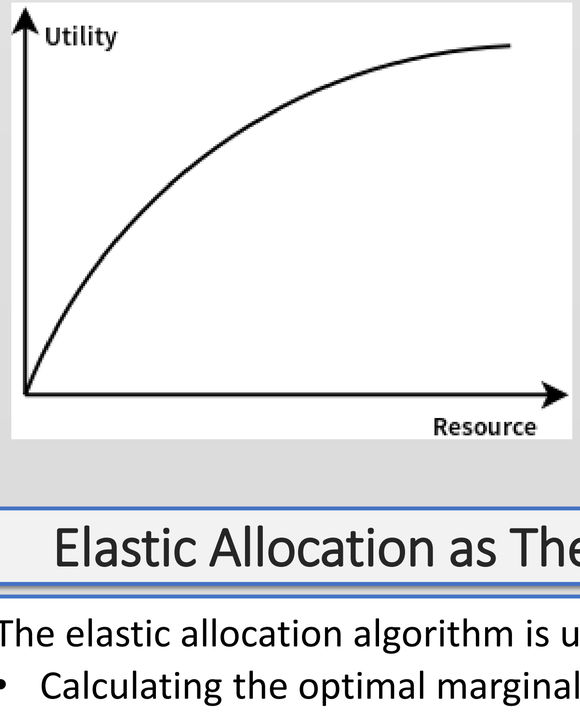
Network utility maximization (NUM) concept can be used:

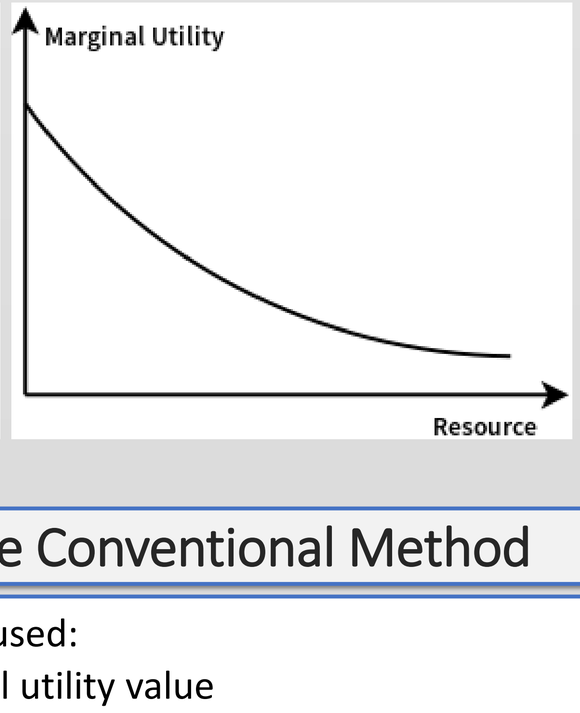
- Considered that every user has an utility (satisfaction level)
- Better than common metrics (throughput, data rate)

The utility function U(r):

- An arbitrary monotonically nondecreasing concave function
- Relates utility with the allocated resource
- There is also marginal utility function u(r)

$$U(r) = 1 - e^{-p \times r \times q} \qquad u(r) = \frac{dU(r)}{dr}$$





Elastic Allocation as The Conventional Method

The elastic allocation algorithm is used:

- Calculating the optimal marginal utility value
- Deriving allocated blocks for each user using that value

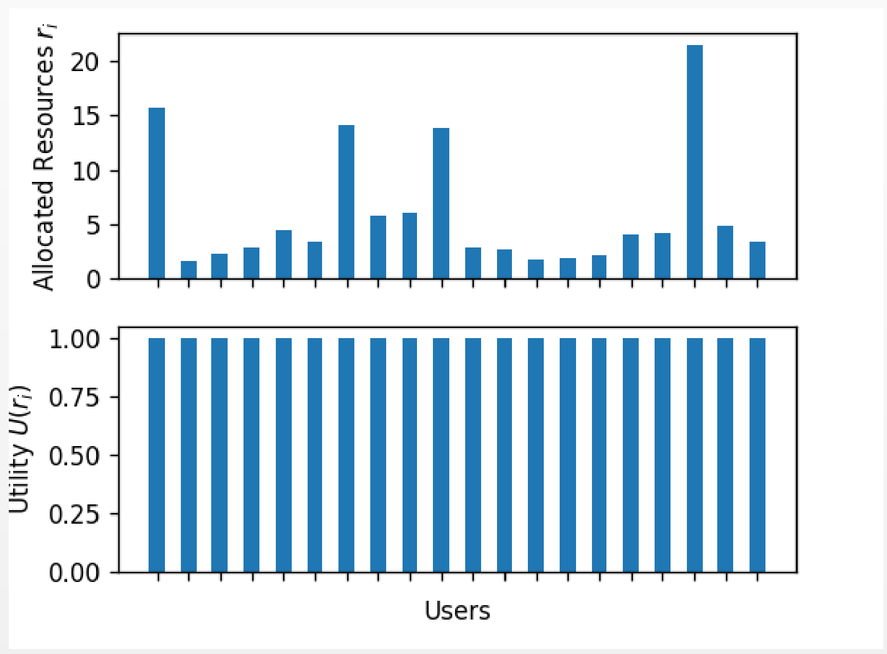
It has been proved that the allocation is optimal as long as:

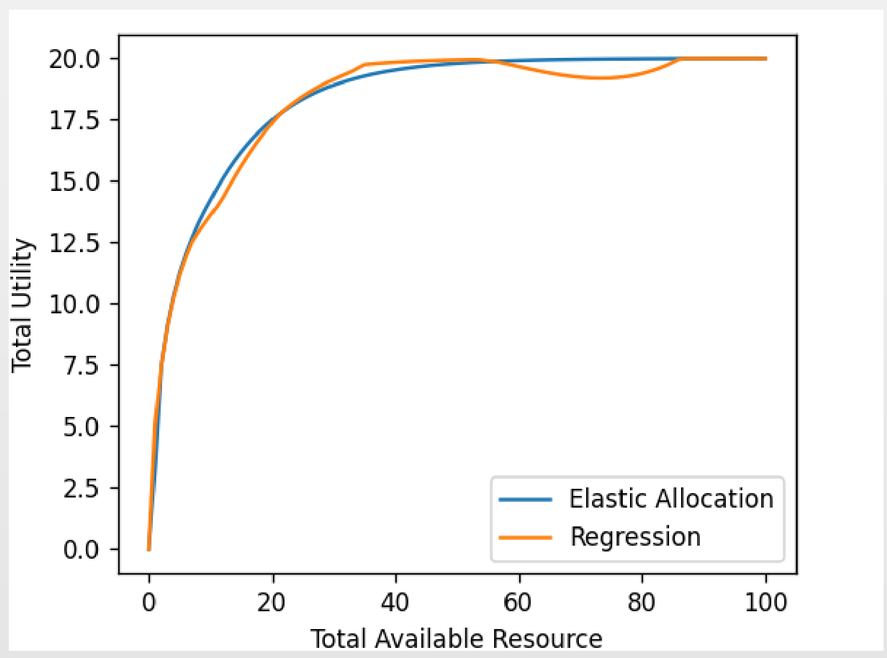
- Every user has a concave utility function
- Every user has the same marginal utility
- There are no available resource blocks left after the allocation.

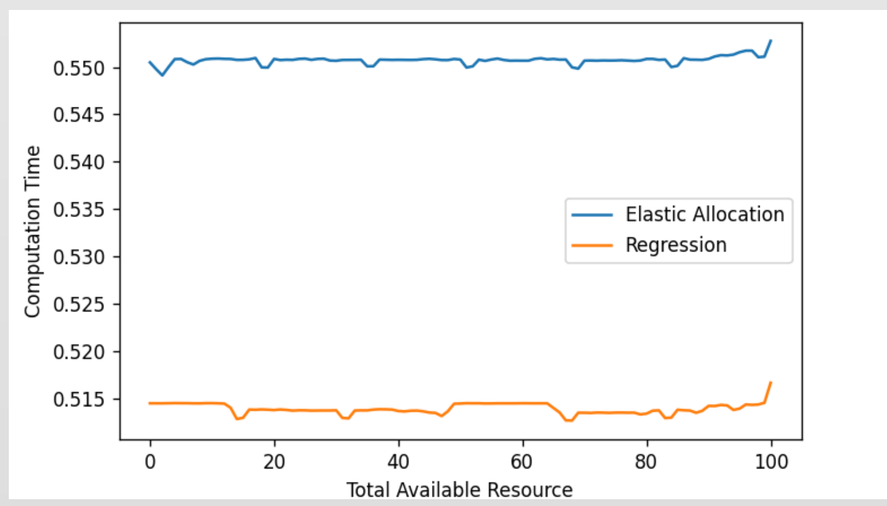
The Machine Learning Method

- A multivariate 3rd degree polynomial regression analysis was employed.
- User count, amount of resource and statistical parameters of all user channel coefficients were used as features.
- The optimal marginal utility point was used as the output.

Results







- The regression predictions are highly accurate
- Computation times 7% to 9% shorter for regression
- The time difference scales with the increasing user count

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