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**Graph Neural Networks for Stock Portfolio Optimization**

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## Introduction

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## Literature overview

The problem of stock portfolio optimization can be traced to the middle of the 20th century. One of the classical approaches is the Capital Asset Pricing Model and its application to finance in Markowitz work (Markowitz, 1952). With the development of financial markets, the question of rational portfolio allocation was developed further with the establishment of Efficient Market Hypothesis EMH (Fama, 1969).

The development of neural networks has opened up a new arsenal of opportunities for researchers to study the issue of optimizing the securities portfolio. One of the features of the optimization problem is the relationship of assets over time, and the evolution of this relationship, often measured using a covariance matrix, has been and remains the most complex component of the analysis. The development of graph neural networks in recent years has prompted researchers to develop new optimization methods. Currently there are three separate problems where graph models can be applied: 1) prediction of markets movement as a whole, 2) prediction of the individual stock movements, the optimization of the portfolio allocation. The latter problem is the one I want to discuss in this work.

Most of the literature is concentrated on predicting individual stock movements like GC-CNN (Chen W, 2021), which tried to combine Convolutional Neural Networks with Graph-Based networks to grasp the relations between stocks and individual stocks’ features. The development of Graph-based approach was done by introduction of self-attention mechanism (Shibo Feng, 2022).

## Graph Models overview

There are several architectures has been proposed in graph neural networks:

(<https://www.frontiersin.org/articles/10.3389/fgene.2021.690049/full>)

1. Graph Neural Network
2. Graph Convolutional Networks
   1. Spectral-Based GCN
   2. Spatial-Based GCN
   3. Graph Attention Networks
   4. Graph Autoencoder Networks

## Bibliography

Chen W, J. M. (2021). A novel graph convolutional feature based convolutional neural network for stock trend. *Information Sciences, 556*, pp. 67-94.

Fama, E. F. (1969). The Adjustment of Stock Prices to New Information. *International Economic Review, 10*, pp. 1-21.

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance, 7*, pp. 77-91.

Shibo Feng, C. X. (2022). Relation-aware dynamic attributed graph attention network for stocks recommendation. *Pattern Recognition, 121*, pp. 108-119.