NATIONAL UNIVERSITY OF SINGAPORE

Master's of Computing (General-Track)



Alpha Tree Search and Machine Learning Approaches to Optimising Real Estate Portfolios

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Internal Capstone Project for AY2023/2024

ABSTRACT

An internal project about applying genetic algorithm to search for optimal alphas. State the major contribution:

DECLARATION

I hereby declare that this project report is my original work and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in this report.

This report has also not been submitted for any degree in any university previously.

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I would like to thank Professor Liu Lili for her guidance, support and encouragement throughout the course of this project. Working with Professor Lili has been a great learning experience, getting to learn much more about machine learning and its applications to finance in solving some challenges faced by industry practitioners.

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INTRODUCTION

The saying goes that once a profitable trading strategy has been discovered and traded on by enough people, its profits will be eroded away and it will cease to be profitable. Traders and investors appear to be playing a neverending game of "Hide-and-Seek" in search of profitable trading formulas. Due to the increasingly dynamic nature of the financial markets, traditional financial time-series forecasting models which are static in nature are becoming less effective than machine learning models in picking the best investments (Sheth & Shah, 2023).

1.1 Problem Definition

Optimising Real Estate Portfolios

1.2 Motivations

1.3 Major Contribution and Creativity

I. Background

FINANCIAL TERMINOLOGY AND CONCEPTS

2.1	Kev	Terms
	,	

- 2.1.1 Stock
- 2.1.2 Real Estate Investment Trusts (REITs)
- 2.1.3 Portfolio
- 2.2 Evaluating Investments with Data
- 2.2.1 Technical Analysis with Price Volume Data
- 2.2.1.1 Profits and Loss (PnL)
- 2.2.1.2 Risk and Volatility
- 2.2.1.3 Sharpe Ratio
- 2.2.2 Fundamental Analysis with Financial Statements

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- 2.2.2.1 Income Statement
- 2.2.2.2 Balance Sheet
- 2.2.2.3 Cash Flow Statement
- 2.2.3 Alpha Formulas
- 2.2.4 Other Methods of Analyses

LITERATURE REVIEW OF PORTFOLIO OPTIMISATION TECHNIQUES

- 3.1 Optimal Portfolio Theory
- 3.2 Traditional Time-Series Analysis
- 3.3 Machine Learning Techniques
- 3.4 Comparison of Techniques
- **3.4.1** Scope
- 3.4.2 Profitability
- 3.4.3 Predictive Accuracy

II. Innovation

DATASETS

- 4.1 Extended Fundamental Data Features
- 4.2 Feature Selection with Decision Trees

METHODOLOGY

- Machine Learning for REITs Portfolio Op-5.1 timisation
- MLR / NN / LSTM Predictions with Extended 5.1.1 **Features**
- 5.1.2 Trade Execution Logic
- 5.1.3 **Performance Evaluation**
- Genetic Algorithm Search for Outperform-5.2 ing Alphas
- Alpha Tree 5.2.1
- Application of Genetic Algorithms to Alpha Trees 5.2.2

4

- 5.2.2.1**Objective Function**
- 5.2.2.2Selection
- 5.2.2.3Crossover
- **5.2.2.4** Mutation
- Portfolio Allocation Using Alpha 5.2.3
- **Performance Evaluation** 5.2.4

III. Experiments

POST-PROCESSED FINANCIAL DATASETS

MACHINE LEARNING RESULTS

- 7.1 Evaluating Stock Price Predictions
- 7.1.1 Multiple Linear Regression (MLR)
- 7.1.2 Neural Networks (NN)
- 7.1.3 Long-Short Term Memory (LSTM)
- 7.2 Trade Execution Results with Different
 Parameters
- 7.3 Overall Evaluation of Performances

ALPHA TREE SEARCH RESULTS

- 8.1 Alphas Generated
- 8.1.1 Initial Set
- 8.1.2 Intermediate Alphas
- 8.1.3 Best Performing Alphas
- 8.2 Portfolio Allocation Results with Best Performing Alphas
- 8.3 Overall Evaluation of Performance

CONCLUSION

- 9.1 Benchmarking Against Index Funds
- 9.2 Comparing Results with Literature Review
- 9.3 Key Findings
- 9.4 Major Contribution and Creativity
- 9.5 Future Work
- 9.5.1 More Operators and Features for Alphas



Figure 9.1: The Universe

REFERENCES

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