**MF 796**

**Computational Methods of Mathematical Finance**

**Spring 2024**

**Course Project Proposal**

**Project Theme ： Enhancing Option Pricing with Deep Learning Techniques**

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**Content**

[1. Research Background and Research Objectives 2](#_Toc1610592865)

[2. Research Methodology 2](#_Toc202911620)

[3. Expected Outcomes 3](#_Toc131565904)

[4. Timeline 3](#_Toc1467475765)

1. Research Background and Research Objectives

Option pricing remains a critical area of focus in financial markets, with practical applications spanning risk management, speculative trading, and strategic investment planning. Traditional numerical methods like Monte Carlo simulations, Fourier transforms, and quadrature have been the backbone of option pricing, offering robust frameworks to handle various pricing scenarios. However, these methods face challenges with high-dimensional data and complex market conditions. Deep learning, having shown significant promise in fields such as NLP and computer vision, is emerging as a potent tool for financial modeling, including option pricing. Preliminary research indicates that deep learning can potentially outperform traditional methods in accuracy and efficiency, adapting to complex market dynamics and capturing intricate patterns in financial data.

The objective of this research is to develop a deep learning-based model for option pricing and to compare its performance with traditional numerical methods including Fourier transform, Monte Carlo simulations, and quadrature methods. This comparison aims to identify the most effective approach for option pricing, considering factors such as computational efficiency, accuracy, and the ability to handle high-dimensional scenarios. By leveraging deep learning, this research seeks to overcome the limitations of traditional methods, offering a more adaptable and powerful tool for financial modeling and option pricing in the modern financial landscape.

1. Research Methodology

Deep Learning Model Development: Design and train a deep learning model for pricing options. The model will learn from historical option pricing data, capturing the underlying asset's price movements and volatility.

Comparison Framework: Implement traditional numerical methods (Fourier transform, Monte Carlo simulations, quadrature methods) to serve as benchmarks for performance comparison.

Evaluation Metrics: Assess models based on accuracy, computational efficiency, and their ability to handle high-dimensional data.

1. Expected Outcomes

Innovative Pricing Model: The deep learning model aims to surpass traditional methods in accuracy and efficiency, providing a robust tool for option pricing.

Comparative Analysis: A comprehensive comparison of deep learning and traditional methods, highlighting strengths and limitations of each approach.

Insights into Financial Markets: Enhanced understanding of market dynamics and option pricing mechanisms through deep learning models.

1. Timeline

**Week 1 (Feb 20 - Feb 26):** Project Setup

Finalize project proposal and objectives.

Review and summarize relevant literature.

**Week 2 (Feb 27 - Mar 5)**: Data Collection and Preprocessing

Collect historical pricing data and relevant financial indicators.

Preprocess data for training and testing.

**Weeks 3-4 (Mar 6 - Mar 19)**: Model Development and Training

Design deep learning model architecture.

Begin training with preliminary data.

**Weeks 5-6 (Mar 20 - Apr 2)**: Model Refinement

Evaluate initial model performance.

Adjust parameters and enhance training.

**Weeks 7-8 (Apr 3 - Apr 16)**: Implementation of Traditional Methods

Develop and test traditional option pricing models.

Compare initial results with deep learning model.

**Week 9 (Apr 17 - Apr 23)**: Comparative Analysis and Optimization

Detailed performance comparison between methods.

Optimize deep learning model based on findings.

**Week 10 (Apr 24 - Apr 30)**: Final Evaluation, Documentation, and Presentation

Complete final model evaluations.

Prepare and finalize the project paper.

Prepare and deliver the final presentation on April 30.

**References**

1. 1. Shen, Z. (2019). "Numerical Methods for High-Dimensional Option Pricing Problems" - Overview of numerical challenges in high-dimensional option pricing and methods to address them, including deep learning approaches.
2. 2. Bayer, C., et al. (2021). "Pricing High-Dimensional Bermudan Options with Hierarchical Tensor Formats" - Discusses a novel approach to addressing dimensionality in option pricing.
3. 3. Yang, Y., Zheng, Y., Hospedales, T.M. (2020). "Gated Neural Networks for Option Pricing: Rationality by Design" - Presents a neural network approach for option pricing that ensures economically rational outputs.