Operation Research

Financial Portfolio Planning

Shiraz University – CSE Department

Professor: Dr. Ziarati

TA: Mohammadmehdi Zamani

Introduction

The project aims to implement sequential decision-making strategies for investment. Assume you're working in the Finance Department of a company. Your current task is to optimize investment decisions over time using predictive models and optimization techniques. There are three distinct opportunities to invest your capital: **Gold**, **Cryptocurrencies (Bitcoin and Ethereum)**, and **Government Bonds**. Each option has unique constraints as described below.

Investment decisions are made **on a weekly basis**. At the beginning of every new week, your available capital reflects the gains or losses from the previous week's choices. Your objective is to define the strategy, constraints, and variables to **maximize the overall revenue**, using linear models and optimization tools.

Investment Options

Gold

- Revenue is influenced by global financial indicators.
- You can only buy/sell gold in **whole number percentages** of its price.

Cryptocurrencies (BTC and ETH)

- Revenue depends on highly volatile market conditions.
- You can buy(long)/sell(short) in any fractional amount of market prices.
- In addition to **spot** trading, **margin** trading is available with **leverage 1 to 3**.

- Margin trades must be closed within **one month**, and losses/gains are amplified accordingly.
- You may define **TP (Take Profit)** or **SL (Stop Loss)** levels. If these are triggered during the week, a part of the position can be automatically closed before the week's end.

Bonds

- The revenue is fixed to **0.55% per month**.
- Once bought, the capital is **locked for one month**.
- Investments can be fractional.

Spot and Margin Trading

In cryptocurrency markets, two common types of trading are **spot trading** and **margin trading**.

Spot Trading

Spot trading involves buying and selling cryptocurrencies for immediate delivery at the current market price. Once a spot trade is executed, ownership of the asset is transferred instantly between buyer and seller. This is the most straightforward type of trading, without any borrowing or leverage.

Margin Trading

Margin trading allows traders to borrow funds from an exchange to increase the size of their trading positions. This enables them to trade with more capital than they actually hold, amplifying both profits and losses. In contrast to futures trading, margin positions **don't have a fixed expiration date** — the position can be held as long as the trader maintains the required margin and pays any associated interest fees. Traders can open either a **long position**, where they profit from a price increase, or a **short position**, where they profit from a price decrease by selling borrowed assets and buying them back at a lower price.

- **Leverage**: Crypto exchanges typically allow leverage up to **10x** on margin trades. For example, with 10x leverage, a trader with $1,000 can open a position worth $10,000.
- **Amplified Risk**: A 10% price move results in a 100% gain or loss on a 10x leveraged position. Higher leverage increases both profit potential and risk of liquidation.

- **Holding Duration**: Margin positions **don't expire**. Traders may hold them for as long as they maintain sufficient margin and pay the interest fees on the borrowed funds.
- **TP/SL Levels**: Traders can set **Take Profit (TP)** and **Stop Loss (SL)** thresholds to automatically close a trade when specific price levels are reached.
- **Margin Calls and Liquidation**: If the trader's equity falls below the maintenance margin level due to market movement, the exchange issues a margin call. If no additional collateral is provided, the position is **liquidated** to prevent further loss.

Implementation Guidelines

Your goal is to **maximize the final wealth** through a combination of forecasting and optimization. The investment simulation begins on **April 1, 2024**, with an initial capital of **$50,000**. Throughout the simulation, track weekly investment decisions and outcomes, monitor asset price fluctuations, and calculate the portfolio value over time. At the end of the simulation period, the final return on investment should be computed based on the overall performance of the chosen strategies.

- **Forecasting:** Predict weekly prices using **linear regression models** applied to historical data (only the close price is required).
- **Data Preprocessing:** For guidance on handling time series data, refer to this tutorial. It provides useful insights into data preparation. Although you must implement the linear model yourself, you may utilize Python libraries such as **NumPy**, **Pandas**, **matplotlib** and etc for data processing and visualization.
- **Modeling Tools:** Use MiniZinc for formulating your linear regression and decision-making models. You may connect Python with MiniZinc using the MiniZinc Python library. Your implementation should include a model file (`.mzn`) and a data file (`.dzn`).

Final Report

While and after implementing the project, a full academic report should be written, containing documentation for the strategies used and the code implemented. This report should detail the steps taken throughout the process, including forecasting, optimization, and decision-making strategies and an analysis of your results. You can use any statistical measurements for your runtime and performance. It's also recommended to add charts to illustrate your decision throughout the time.

Good Luck!