Stock Portfolio Selection Using Two-tiered Lazy Updates

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What is the problem?

Problem: Group trends can be missed when prediction is based on changes of only the individual.

- Knowledge that can be gained from relationships between details is difficult to encode

What is the solution?

Solution: Use a two-tiered algorithm that adapts to individual trends at the bottom level and group trends at the top level

In Portfolio Selection:
- Individual stocks are picked at the low level
- Groups of stocks are picked at the high level
- Isolation of groups allows one stock to be in multiple groups
- Group examples: Tech, Medical, large-cap, blue chip, etc.

Online Portfolio Selection

The Lure of the Stock Market
By making an initial investment of $10 into the New York Stock Exchange in 1962, you could have made $367 million by 1984—requiring only 10 trades and $70's in brokerage fees. Predicting the perfect 10 trades is the virtually impossible challenge.

Portfolio Selection Research
In Online Portfolio Selection, a trader purchases a portfolio of assets (stocks, options, etc.) with a specific goal in mind—typically to maximize return on investment at a reasonable rate of risk.

Sector Level:
- Represent a sector portfolio at time \( t \) as a vector \( q_t \) of weights that correspond to the distribution of wealth between stocks in that sector

Market Level:
- Represent a portfolio at time \( t \) as a vector \( p_t \) of weights that correspond to the distribution of wealth between different sectors

The vectors \( q_t \) and \( p_t \) are determined before the relatives for the day are revealed.

Incorporating Risk
By passing a modified price relative that incorporates risk level for the sector over the last \( d \) days, we try to control risk levels:

\[
\delta_t' = \frac{\prod_{i=d+1}^{d+1} \delta_i}{\max\{\alpha, \sigma(\delta_{d+1})\}}
\]

Two-tiered Online Lazy Updates

Sector Level Online Lazy Updates (SOLU)
OLU objective function:

\[
q_{t+1} = \arg\min_{p \in \mathbb{P}} -\eta \log(q^T x_t) + \alpha ||q - q_t||_1 + \frac{1}{2} ||q - q_t||_2^2
\]

where \( x_t \) is the vector of stock price relatives on day \( t \)

Market Level Online Lazy Updates (MOLU)
OLU objective function:

\[
p_{t+1} = \arg\min_{p \in \mathbb{P}} -\eta \log(p^T x_t) + \alpha ||p - p_t||_1 + \frac{1}{2} ||p - p_t||_2^2
\]

where \( x_t \) is the vector of SOLU price relatives on day \( t \)

Results

- At a transaction cost of 0.1%, 30 day periods provide the best balance between new and old information
- Low \( d \) -> focus on new, High \( d \) -> focus on past
- Low risk misses opportunities for profit, but can reduce losses
- High risk follows extreme upswings and downswings
- We are able to compete with the top sector at 0.1% transaction cost
- Outperform 9/10 sectors at 1% transaction cost
- MOLU works best when \( \eta \) and \( \alpha \) are in balance
- \( \eta \) too high -> too much trading
- \( \alpha \) too high -> too conservative