

BNED Algorithmic Trading System

Problem Description

The main problem this assignment addresses is how to create trading systems that work for different types of investors with varying risk preferences. Conservative investors want smaller positions and safer trades, while aggressive investors are willing to take bigger risks for potentially higher returns. This assignment also looks at the problem of combining two different trading strategies that often give conflicting signals. Momentum trading follows price trends and assumes that rising prices will continue rising, while mean-reversion trading assumes that extreme price movements will reverse back to normal levels (Investopedia). The assignment uses Barnes & Noble Education (BNED) stock as a test case because it showed extreme price movements during the research period, falling from over \$160 to under \$20 (yfinance). This decline provides a challenging environment to test whether the multi-level risk system can protect investors during bad market conditions.

Data Preparation and Pipeline

The data collection process uses Yahoo Finance to gather two years of daily stock prices, including opening price, highest price, lowest price, closing price, and trading volume. This timeframe provides enough historical information to test properly while keeping analysis manageable. The final dataset contains 502 rows and 22 columns, with the system including error checking to handle missing data. The system calculates technical indicators that help identify trading opportunities. Moving averages smooth out price movements to show trends, using both 10-day and 30-day periods to capture short-term and longer-term patterns (Investopedia). RSI measures whether a stock is overbought or oversold using a standard 14-day

calculation period (Investopedia). Bollinger Bands create upper and lower boundaries around the stock price based on recent volatility, helping identify when prices might be unusually high or low (Investopedia). Additional calculations include volume analysis to identify periods of unusual trading activity and momentum measures to determine how fast prices are changing (Investopedia). The system also calculates volatility using 20-day periods to understand how much the stock price typically moves.

Research Design

The research design creates a trading approach that combines momentum and mean-reversion strategies. When markets are volatile, the system gives more weight to mean-reversion signals because extreme price movements can reverse (Investopedia). When markets are calm, momentum signals receive more weight because trends are more likely to continue during stable periods (Investopedia). Momentum signals require several conditions to align: short-term moving averages above long-term averages, positive price momentum exceeding risk-adjusted thresholds, and trading volume above normal levels (Investopedia). Mean-reversion signals look for different conditions: prices near Bollinger Band boundaries, oversold RSI readings, and significant price movements that suggest temporary price dislocations (Investopedia). The backtesting process simulates historical trading using assumptions about timing and execution, starting with \$100,000 in initial capital. Risk management occurs at multiple levels, including individual trade sizing and overall exposure limits.

Programming & Results

The main trading system class separates data handling, analysis, signal generation, trade execution, and performance measurement into clear methods. Technical indicator calculations

use financial analysis with proper handling of special cases like insufficient data or unusual market conditions. The RSI calculation uses the established smoothing method for gains and losses, while Bollinger Bands correctly implement standard deviation scaling around moving averages (Investopedia). Volume analysis includes safeguards against zero-volume days that could distort calculations (Investopedia). Trade simulation includes position sizing that accounts for available funds and practical trading constraints. The system maintains accurate records of all trades and capital changes throughout the testing period.

The backtesting results demonstrate the system's effectiveness across different risk tolerance levels during BNED's challenging market conditions. All three risk configurations significantly outperformed the buy-and-hold strategy, though with varying trade frequencies and risk profiles.

Conservative Risk Strategy	Moderate Risk Strategy	Aggressive Risk Strategy
Total Return: -1.82%	Total Return: -4.17%	Total Return: -3.24%
Buy & Hold Return: -94.43%	Buy & Hold Return: -94.43%	Buy & Hold Return: -94.43%
Excess Return: 92.61%	Excess Return: 90.26%	Excess Return: 91.19%
Total Trades: 6	Total Trades: 8	Total Trades: 8
Win Rate: 33.33%	Win Rate: 25.00%	Win Rate: 25.00%
Sharpe Ratio: -0.944	Sharpe Ratio: -0.912	Sharpe Ratio: -0.860
Final Capital: \$98,180.14	Final Capital: \$95,833.85	Final Capital: \$96,760.84

The results reveal important insights about multi-level risk management during volatile market conditions. First, all risk levels achieved substantial excess returns compared to the buy-and-hold strategy, preserving over 90% of capital while the stock declined 94.43%. This demonstrates the system's primary strength in risk management and capital preservation.

The conservative approach generated the highest excess return (92.61%) with only 6 trades, suggesting that higher trading thresholds helped avoid some unprofitable transactions. The moderate and aggressive strategies executed more trades (8 each) but achieved slightly

lower excess returns, showing that increased trading activity in this declining market environment did not necessarily improve performance.

The win rates across all strategies were relatively low (25-33%), which is due to the severe downtrend in BNED stock. However, the negative Sharpe ratios improved from conservative (-0.944) to aggressive (-0.860), suggesting that the more active trading strategies achieved better risk-adjusted returns despite lower absolute excess returns.

Conclusion

This assignment demonstrates the effectiveness of a multi-level risk trading system that combines momentum and mean-reversion strategies. The backtesting results on BNED stock during a severe market decline validate the system's primary strength in capital preservation. While the low win rates (25-33%) and negative Sharpe ratios reflect downturned market conditions, the conservative approach's performance with fewer trades (6 vs 8) provides valuable insights into the relationship between trading frequency and effectiveness. The system's ability to adapt risk parameters while maintaining consistent capital protection demonstrates the trading approaches that prioritize risk management. This offers a viable framework for automated trading systems across different risk tolerance levels.

References