Artificial Intelligence in Algorithmic Trading: An Extended Guide

Author Name

Universidad de las Américas Puebla

August 25, 2025

Abstract

This document provides a template for reports in the "AI in Financial Services" course, using EB Garamond for prose and Libertinus Math for formulas. It includes a cover page, abstract, table of contents, and sample sections for math and text. Additional content demonstrates tables, code, and references.

Contents

1 Overview

This document is a minimal example using EB Garamond for prose and libertinust1math for formulas. Links like this one are active.

2 Introduction to Algorithmic Trading

Algorithmic trading uses computer programs to execute trades at speeds and frequencies that are impossible for humans. Algorithms can be based on timing, price, quantity, or any mathematical model. The use of artificial intelligence (AI) has further enhanced the capabilities of algorithmic trading by enabling adaptive strategies and pattern recognition.

2.1 Historical Context

The evolution of algorithmic trading began in the 1970s with the introduction of electronic trading platforms. Over the decades, advancements in computing power and data availability have led to the widespread adoption of automated trading systems.

2.2 Benefits and Risks

Algorithmic trading offers several benefits:

- Increased speed and accuracy of order execution.
- Reduced transaction costs.
- Ability to backtest strategies using historical data.

However, it also introduces risks such as:

- Systematic errors due to bugs in code.
- Market instability from high-frequency trading.
- Overfitting of models to historical data.

3 Math sample

Let S_t follow a geometric Brownian motion:

$$dS_t = \mu S_t\,dt + \sigma S_t\,dW_t, \qquad \Rightarrow\ S_T = S_0 \exp\!\Big((\mu * \tfrac{1}{2}\sigma^2)T + \sigma\sqrt{T}\,Z\Big).$$

The Black–Scholes call price:

$$C = S_0 e^{*qT}\Phi(d_1) * K e^{*rT}\Phi(d_2), \quad d_{1,2} = \frac{\ln(S_0/K) + (r * q\,,\, \tfrac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}.$$

This is how the stats operator, like the expected value, variance, and other math functions, look like with the selected font:

$$\mathbb{E}[X], \quad \mathbb{V}[X], \quad \mathbb{P}(X \text{ Ë } A) \int f(x)\,dx, \quad \frac{d}{dx}f(x), \quad (f(x), \quad \partial_x f(x)$$

4 Machine Learning in Finance

Machine learning (ML) techniques are widely used in financial markets for tasks such as price prediction, portfolio optimization, and risk management. Common algorithms include linear regression, decision trees, and neural networks.

4.1 Example: Linear Regression

Suppose we want to predict the price of a stock based on historical features. The linear regression model is:

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n + \epsilon$$

where y is the predicted price, x_i are features, β_i are coefficients, and ϵ is the error term.

5 Sample Table

Table 1 summarizes common algorithmic trading strategies.

Table 1: Common Algorithmic Trading Strategies

Strategy	Description	Example
Trend Following	Buy/sell based on price trends	Moving average crossover
Mean Reversion	Trade on price deviations from mean	Pairs trading
Market Making	Provide liquidity by quoting prices	Bid-ask spread capture

6 Sample Code

Below is a Python code snippet for a simple moving average crossover strategy.

Listing 1: Simple Moving Average Crossover

```
import pandas as pd

def sma_crossover(prices, short=20, long=50):
    prices['SMA_short'] = prices['Close'].rolling(window=short).mean()
    prices['SMA_long'] = prices['Close'].rolling(window=long).mean()
    prices['Signal'] = 0
    prices.loc[prices['SMA_short'] > prices['SMA_long'], 'Signal'] = 1
    prices.loc[prices['SMA_short'] < prices['SMA_long'], 'Signal'] =
        -1
    return prices
```

7 Conclusion

Artificial intelligence and machine learning have transformed algorithmic trading, enabling more sophisticated and adaptive strategies. However, practitioners must be aware of the risks and ensure robust testing and validation of their models.

8 References

- Hull, J. C. (2018). *Options, Futures, and Other Derivatives*. Pearson.
- Chan, E. (2013). *Algorithmic Trading: Winning Strategies and Their Rationale*. Wiley.
- Investopedia: Algorithmic Trading