Digital Finance 3: Technology in Finance

Lesson 29: Algorithmic Trading Concepts

FHGR

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Algorithmic trading: where finance meets computer science.

Learning Objectives

By the end of this lesson, you will be able to:

- Classify different types of algorithmic trading strategies
- Design and execute backtesting frameworks
- Identify and avoid common backtesting pitfalls
- Understand overfitting in trading models
- Account for transaction costs and market impact
- Set realistic performance expectations

Overfitting produces excellent in-sample fit but poor out-of-sample predictions.

What is Algorithmic Trading?

Definition:

- Automated execution based on rules
- No human intervention
- Computer algorithms make decisions
- Processes data faster than humans

Market Share:

- US equities: 70-80% of volume
- Futures: 60-70% 92

Key Advantages:

- Speed (microseconds)
- Consistency (no emotions)
- Backtesting capability
- Scalability

Challenges:

- Overfitting to historical data
- Model decay (regime changes)
- Technology costs
- Regulatory scrutiny

Clear definitions are essential for understanding complex technical concepts. [Source: DeFi Llama, DeFi Pulse 2024]

Types of Strategies

Execution Algorithms:

- VWAP, TWAP
- Minimize market impact
- Cost minimization

Market Making:

- Provide liquidity
- Profit from spread
- High-frequency trading

Statistical Arbitrage:

- Mean reversion
- Pair trading
- Market-neutral

Momentum:

- Follow trends
- Breakout strategies
- Moving averages

ML-Based:

- Prediction models
- Alternative data
- Classification/regression

HFT:

- Ultra-short holding
- Latency arbitrage
- Co-location required

Source: Academic AI/ML literature and industry adoption studies

Backtesting Framework

Steps:

1. Define strategy rules
2. Acquire historical data
3. Simulate trades
4. Calculate returns (net of costs)
5. Evaluate metrics
6. Iterate and refine

Key Metrics:

- Total return
- Sharpe ratio (risk-adjusted)
- Maximum drawdown
- Win rate
- Profit factor

Realistic Targets:

- Sharpe ¿ 1.5: Good
- Sharpe ¿ 2.0: Very good
- Sharpe ¿ 3.0: Exceptional (or overfitting?)

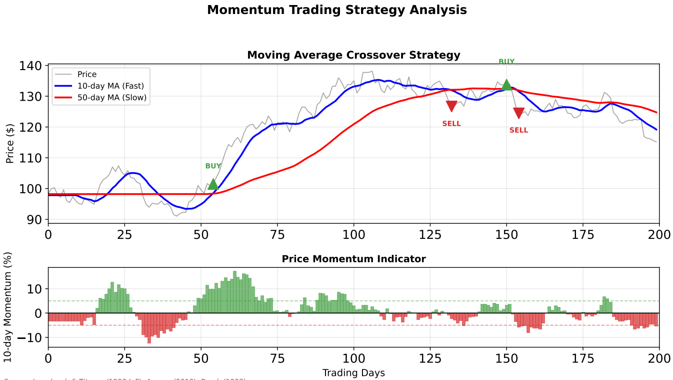
Common Pitfalls:

- Look-ahead bias
- Survivorship bias
- Data snooping
- Ignoring costs
- Market impact
- Overfitting

Warning: Backtest performance usually overstates live performance.

Source: Academic AI/ML literature and industry adoption studies

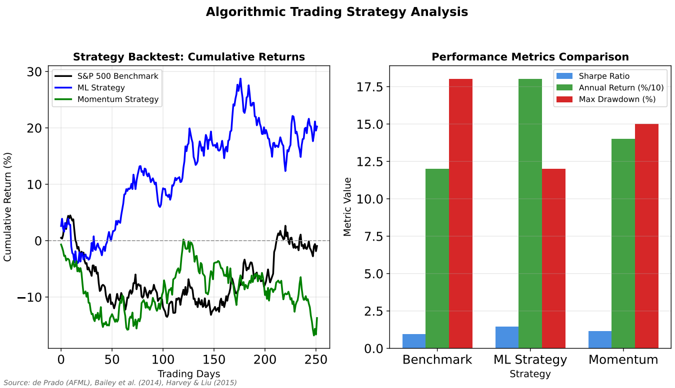
Momentum Strategy Performance



Source: Jegadeesh & Titman (1993 JoF), Asness (2013), Brock (1992)

Momentum strategies buy winners and sell losers, exploiting short-term trends in asset prices.

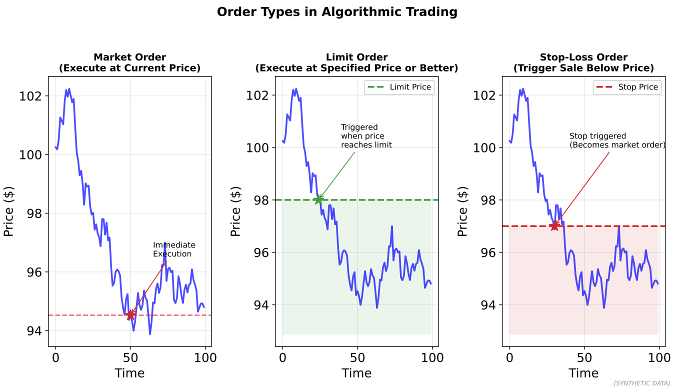
Trading Strategy Backtest Results



Source: de Prado (AFML), Bailey et al. (2014), Harvey & Liu (2015)

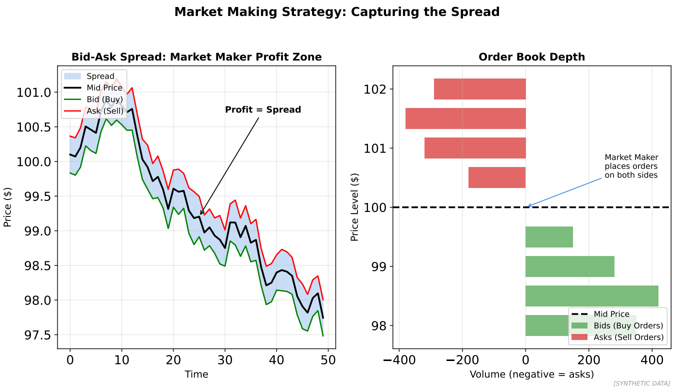
Backtesting reveals strategy performance metrics including returns, drawdowns, and Sharpe ratios.

Order Types and Execution



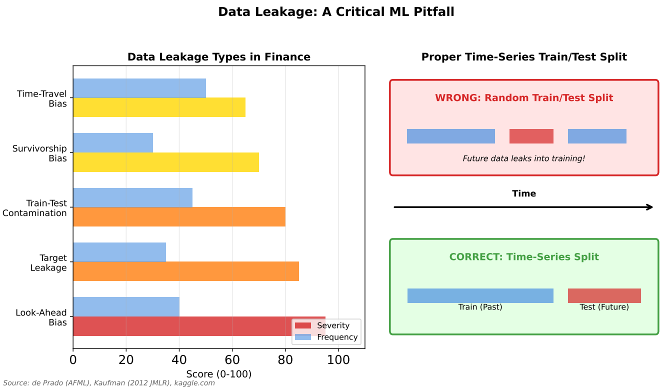
Different order types serve different execution objectives: market orders for speed, limit orders for price control.

Market Making Spread Dynamics



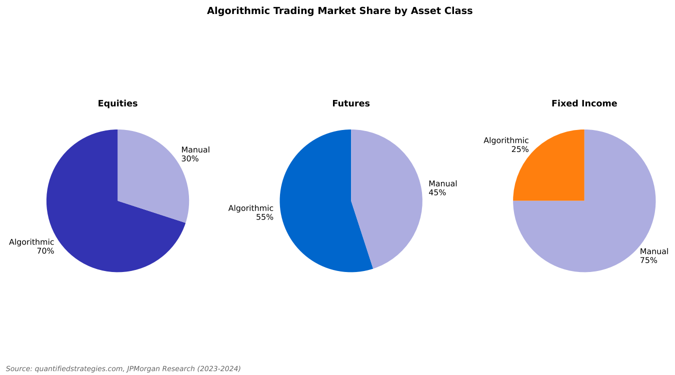
Market makers profit from bid-ask spreads while providing liquidity to the market.

Data Leakage in Backtesting



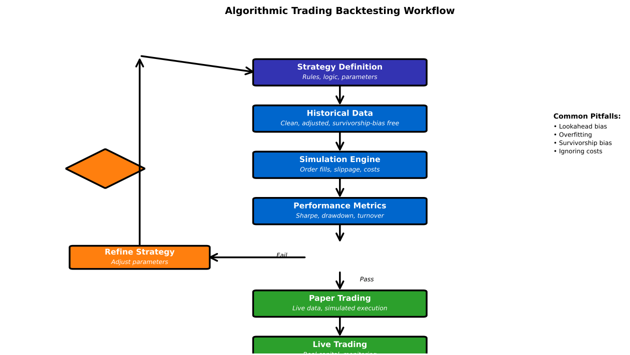
Look-ahead bias occurs when future information leaks into historical simulations, inflating backtest results.

Algorithmic Trading Market Share



Algorithmic trading now dominates equity markets, exceeding 80 percent of volume.

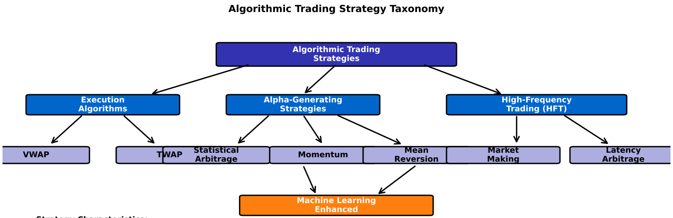
Backtesting Workflow



Source: de Prado (Advances in Financial ML), Aronson (EBTA), Zipline

Rigorous backtesting is essential but can mislead through overfitting and survivorship bias.

Algorithmic Strategy Types



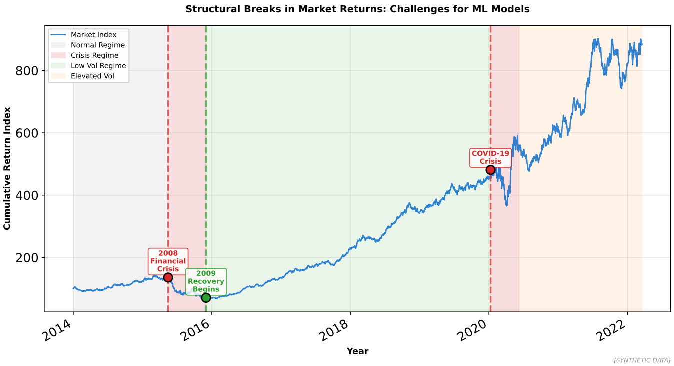
Strategy Characteristics:

- Execution: Minimize market impact
- Alpha-Generating: Exploit market inefficiencies
- HFT: Ultra-low latency, high turnover
- ML-Enhanced: Adaptive pattern recognition

Source: Kissell (Algo Trading), CFA Institute, Harris (Trading & Exchanges)

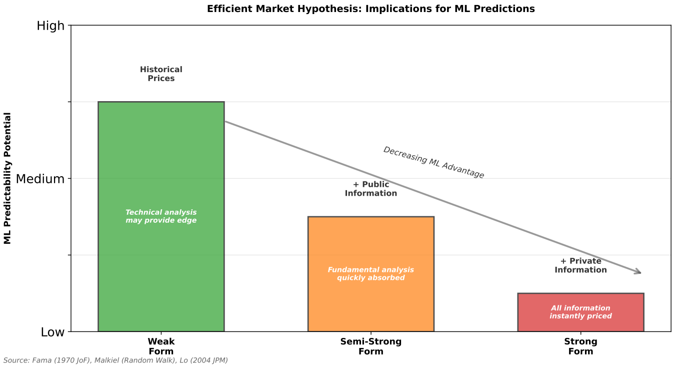
Algorithmic strategies range from high-frequency to fundamental trend-following.

Structural Break Detection



Detecting regime changes is critical for adaptive trading strategies.

Efficient Market Hypothesis Implications



EMH suggests that consistently beating the market through analysis is difficult.

Algorithmic Trading Concepts: Key Takeaways

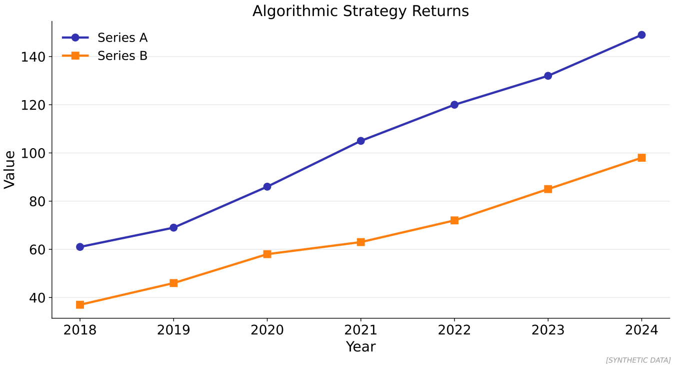
Key Takeaways:

- Algorithmic trading dominates modern markets
- Many strategy types (execution, market making, stat arb, ML)
- Backtesting essential but has pitfalls
- Overfitting is the central danger
- Transaction costs matter (0.2-0.5% per round-trip)
- Realistic expectations: Alpha is scarce

Next Lesson: Credit Scoring and Risk Models

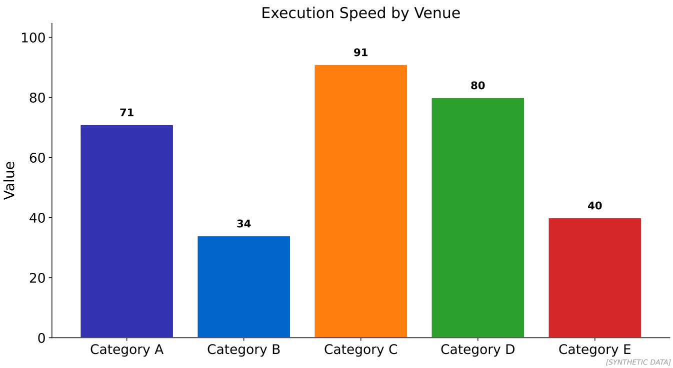
Survivorship bias inflates backtest returns by excluding failed companies from historical data.

Algorithmic Strategy Performance



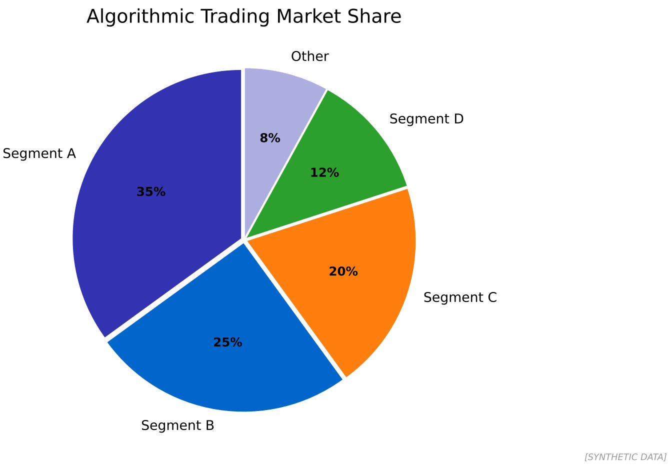
Strategy returns vary by market conditions and execution quality.

Execution Speed by Venue



Latency differences impact execution quality.

Algorithmic Trading by Strategy



Market making and statistical arbitrage dominate volumes.