

Lesson 1: Introduction to Quant Trading Strategy

Concept + Execution = Profit

Quantitative trading involves leveraging data-driven models to identify trading opportunities. The success of a strategy depends on both a sound conceptual framework and effective execution.

1. Retrieving Financial Data and Analysis

Quantitative strategies begin with acquiring reliable financial data.

Techniques

- **APIs** (Application Programming Interfaces): Structured access to financial data from providers such as Yahoo Finance, Quandl, Alpha Vantage.
- **Web Scraping**: Programmatic extraction of data from websites when APIs are unavailable or insufficient.



Common Data Sources

- **News and Social Media**: Used for sentiment analysis.
- **Company Reports**: SEC filings, earnings reports, etc.
- **Market Data**: Price histories, volume, indicators.
- **Search Engines & RSS Feeds**: For collecting broader contextual signals.

2. Data Preprocessing and Cleaning

Raw data is often noisy, incomplete, or inconsistent. Preprocessing ensures that the dataset is clean and suitable for modeling.

The Data Cleaning Cycle



1. **Importing Data:** Load data from CSV, JSON, Excel, SQL, or API responses.
2. **Merging Data Sets:** Combine data from multiple sources based on keys (e.g., date or stock ticker).
3. **Rebuilding Missing Data:** Use forward/backward filling, interpolation, or imputation to fill in gaps.
4. **Standardization:** Ensure uniform formats for time, currency, and categorical variables.
5. **Normalization:** Scale numerical data to a comparable range (e.g., using Min-Max or Z-score normalization).
6. **De-duplication:** Remove redundant records to avoid bias.
7. **Verification and Enrichment:** Validate data integrity and enhance it with external information if needed.
8. **Exporting Data:** Save cleaned data for modeling or future reuse.

3. Data Visualization

Visualization helps in:

- Exploring data trends and patterns.
- Identifying outliers or structural breaks.
- Communicating insights effectively.

Useful Python Packages

- `matplotlib.pyplot` Basic plotting tool in Python.
- `Seaborn` Statistical plots built on top of Matplotlib.
- `Plotly` Interactive visualizations, ideal for dashboards.

You will learn to build custom graphs using these tools later in the course.

Useful APIs: <https://finance.yahoo.com>, <https://www.quandl.com>, <https://www.alphavantage.co>

均线交叉策略 (Moving Average Crossover Strategy)

一、什么是“均线交叉策略”？

用两条不同周期的移动平均线（短期 & 长期）来判断趋势变化，并生成买卖信号。

举例：

- 短期均线：如 5 日、10 日、20 日；
- 长期均线：如 50 日、100 日、200 日；

策略核心逻辑：

- 当短期均线上穿长期均线 \Rightarrow 趋势转强，买入信号
- 当短期均线下穿长期均线 \Rightarrow 趋势转弱，卖出信号

二、定义

什么是移动平均线 (MA)？

- 简单移动平均线 (SMA)：过去 N 天的收盘价平均：

$$SMA_N(t) = \frac{1}{N} \sum_{i=0}^{N-1} \text{Close}(t-i)$$

- 指数移动平均线 (EMA)：对最近价格赋予更高权重的加权平均。

三、常见交叉策略组合

短期均线	长期均线	名称	应用场景
50 日	200 日	黄金交叉 & 死亡交叉	长期趋势判断
5 日	20 日	短线动量交叉	短期波段交易
EMA12	EMA26	MACD 原型	动量 + 趋势分析

四、买卖信号规则（最常见形式）

1. 买入信号 (Golden Cross)：

- 如果：短期均线 _{t} > 长期均线 _{t}
- 且前一日：短期均线 _{$t-1$} \leq 长期均线 _{$t-1$}
- 则产生“买入”信号。

2. 卖出信号 (Death Cross)：

- 如果：短期均线 _{t} < 长期均线 _{t}
- 且前一日：短期均线 _{$t-1$} \geq 长期均线 _{$t-1$}
- 则产生“卖出”信号。

Heikin-Ashi (HA) 蜡烛形态

一、Heikin-Ashi 是什么？

Heikin-Ashi (日语: 平均足) 是一种“改良版 K 线图”，用**平均值**计算每根蜡烛线的开盘价、收盘价、高点和低点，**不是真实价格**，而是“合成值”。

二、Heikin-Ashi 的计算公式

假设我们有普通蜡烛图的四个值:

Open, High, Low, Close

Heikin-Ashi 的四个组成部分是:

1. 收盘价 (HA_Close)

$$HA_Close_t = \frac{Open_t + High_t + Low_t + Close_t}{4}$$

就是当前蜡烛的平均值。

2. 开盘价 (HA_Open)

$$HA_Open_t = \frac{HA_Open_{t-1} + HA_Close_{t-1}}{2}$$

是前一根 Heikin-Ashi 蜡烛的开盘和收盘的平均。初始 HA_Open 可设为第一根普通蜡烛的 Open。

3. 最高价 (HA_High)

$$HA_High_t = \max(High_t, HA_Open_t, HA_Close_t)$$

4. 最低价 (HA_Low)

$$HA_Low_t = \min(Low_t, HA_Open_t, HA_Close_t)$$

三、Heikin-Ashi 与普通 K 线对比

特性	普通蜡烛图	Heikin-Ashi
数据来源	实际市场价格	加权平均处理
每根蜡烛独立	是	依赖前一根
趋势识别清晰度	中等	更平滑
反转信号	易被噪声干扰	更可靠

四、Heikin-Ashi 的优势

1. 趋势更清晰（大阳线/大阴线连续出现时趋势通常还在继续）
2. 更少假信号（震荡行情下能过滤掉很多假突破）
3. 适合趋势交易者使用（搭配移动平均线、MACD 效果更好）

五、Heikin-Ashi 的局限性

1. 不显示真实开收盘价（不适合做精确入场/出场）
2. 滞后于真实价格，反应慢（趋势改变识别会延后）
3. 不能用于日内高频交易（不反应即时情绪）

Backtest Performance Metrics

After designing and executing a trading strategy, we evaluate its performance using several Key Performance Indicators (KPIs). These metrics provide insights into profitability, risk, and stability.

1 CAGR (Compound Annual Growth Rate)

- Measures the annualized return of the investment portfolio.
- Example: `CAGR = 0.009404`, which means an annualized return of 0.94%.
- A low CAGR may indicate poor long-term performance.

2 Portfolio Return

- Total return of the portfolio over the backtesting period.
- Example: `portfolio return = 2.1622`, or 216.22% total return.
- Suggests strong overall profitability across the test window.

3 Benchmark Return

- Indicates the return of a market index (e.g., S&P 500) for comparison.
- Example: `benchmark return = 0.140957` or 14.10%.
- The strategy outperforms the market (216.22% vs. 14.10%).

4 Sharpe Ratio

- Measures excess return per unit of risk:

$$\text{Sharpe Ratio} = \frac{R_p - R_f}{\sigma_p}$$

- R_p : Portfolio return
- R_f : Risk-free rate
- σ_p : Standard deviation of portfolio return

- Example: `sharpe ratio = 0.140849`, which is considered low (typically > 1.0 is good).

5 Maximum Drawdown (MDD)

- Measures the largest historical loss from peak to trough:

$$\text{MDD} = \frac{\text{Peak} - \text{Trough}}{\text{Peak}}$$

- Example: `maximum drawdown = -0.064508`, or 6.45%.
- Indicates the worst-case downside during the test period.

6 Calmar Ratio

- Measures the risk-adjusted return:

$$\text{Calmar Ratio} = \frac{\text{CAGR}}{\text{Maximum Drawdown}}$$

- Example: `calmar ratio` = -0.145779 (negative value indicates poor stability).

7 Omega Ratio

- Measures the ratio of gains to losses:

$$\text{Omega Ratio} = \frac{\sum(\text{Profitable Returns})}{\sum(\text{Losing Returns})}$$

- Example: `omega ratio` = 6.63459
- A value above 1.0 implies the strategy is viable (6.63 is very strong).

8 Sortino Ratio

- A variation of the Sharpe Ratio that only considers downside risk:

$$\text{Sortino Ratio} = \frac{R_p - R_f}{\sigma_{\text{downside}}}$$

– σ_{downside} : Downside standard deviation

- Example: `sortino ratio` = 1.362586
- Indicates good risk-adjusted performance under downside volatility (values > 1.0 are desirable).

Trade Statistics and Evaluation

9 Trade Frequency

- **Number of Long Trades:** 10
- **Number of Short Trades:** 8
- **Total Number of Trades:** 18
- Fewer total trades suggest a *low-frequency strategy*.

10 Trade Duration

- **Total Length of Trades:** 28 days (or time units).
- **Average Trade Duration:** 1.56 days
- Short average holding time indicates the strategy may be *short-term or intraday oriented*.

11 Profit per Trade

- **Profit per Trade:** 1201.22
- Despite only 18 trades, each trade generates on average \$1201.22 in profit, indicating strong trade quality.

Performance Summary Table

Metric	Result	Interpretation
CAGR	0.94%	Compound Annual Growth Rate is low
Portfolio Return	216.22%	High cumulative return
Benchmark Return	14.10%	Market benchmark return
Sharpe Ratio	0.14	Low risk-adjusted return
Max Drawdown	-6.45%	Controlled historical loss
Calmar Ratio	-0.1458	Negative, poor stability
Omega Ratio	6.63	Profitable trades dominate losing trades
Sortino Ratio	1.36	Good performance under downside risk
Long Trades	10	Number of long entries
Short Trades	8	Number of short entries
Total Trades	18	Low-frequency strategy
Total Length	28	Total duration in days
Avg Trade Length	1.56	Very short holding periods
Profit per Trade	1201.22	High average profit per trade

Overall Evaluation

- High portfolio return: **216.22%**, significantly outperforming the market benchmark of **14.10%**.
- Maximum drawdown is well-controlled at **6.45%**.
- Omega Ratio of **6.63** indicates the strategy earns significantly more on winning trades than it loses on losing trades.
- High average profit per trade (**1201.22**) despite limited number of trades.
- Low Sharpe Ratio (**0.14**) suggests inefficient risk-adjusted return.
- Sortino Ratio (**1.36**) shows decent performance against downside risk.

Suggested Directions for Optimization

1. **Increase trade frequency:** The strategy currently generates only 18 trades. Try optimizing entry signals to capture more market opportunities.
2. **Improve risk-adjusted return:** The Sharpe ratio is low. Consider adjusting stop-loss mechanisms or volatility filters.
3. **Maintain drawdown control:** The current maximum drawdown (6.45%) is acceptable, but tighter risk control may further enhance robustness.