

# Algorithmic Trading

*by Rotehut*

## 1st Layer



**Algorithmic Trading** - Algorithmic trading means turning a trading idea into an algorithmic trading strategy via an algorithm. The algorithmic trading strategy thus **created can be backtested with historical data to check whether it will give good returns in real markets.** The algorithmic trading strategy can be executed either manually or in an automated way.

## 2nd Layer



**Quantitative Trading** - Quantitative trading involves **using advanced mathematical and statistical models** for creating and executing an algorithmic trading strategy.

## 3rd Layer



**Automated Trading** - Automated trading means completely automating the order generation, submission, and the order execution process. **based on Live Data, Data Drift and Retraining Model**

### Quantitative Analysis / Modeling

- Working on **statistics, time-series analysis, statistical packages** such as Matlab, R should be your favourite activities.
- Exploring **historical data from exchanges and designing new algorithmic trading strategies** should excite you.

### Programming Skills

#### Programming Languages

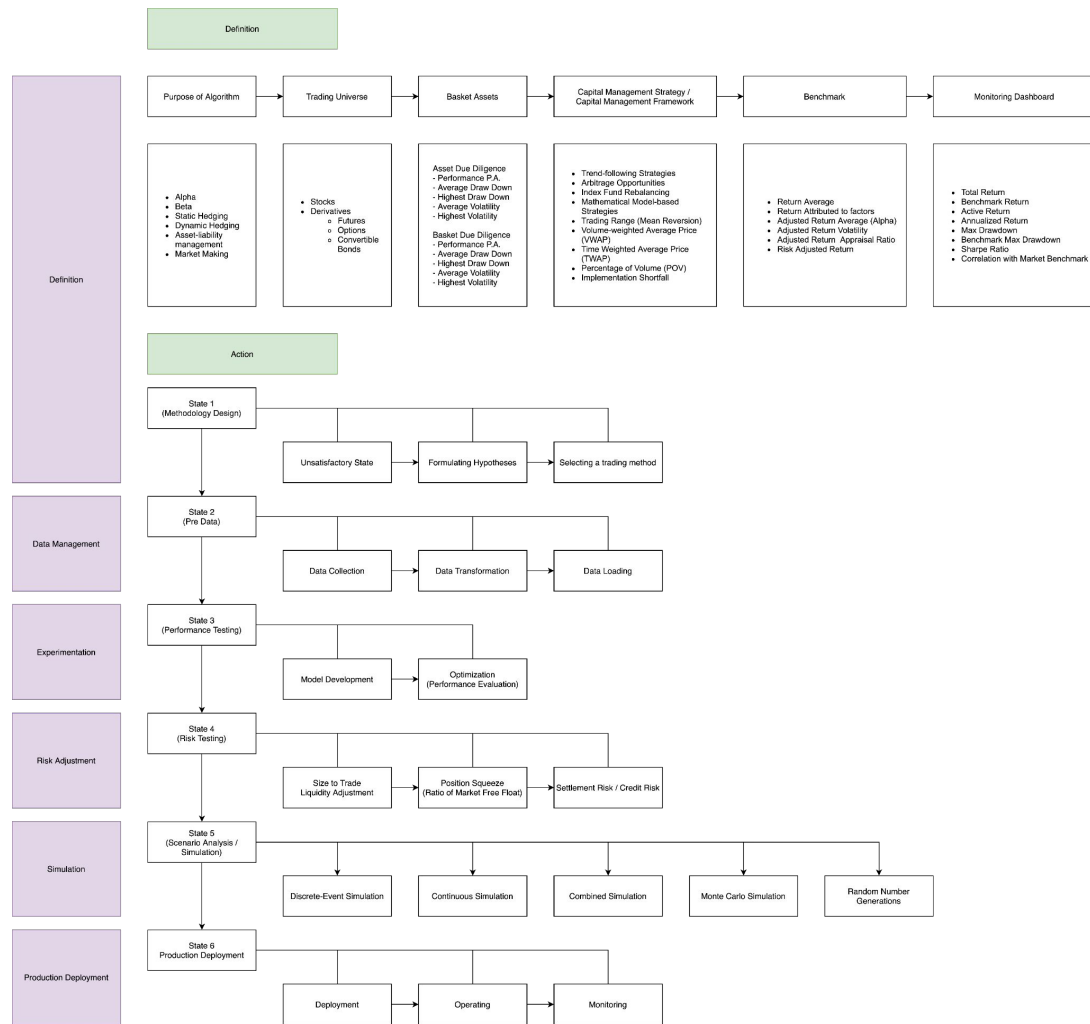
- **C++ (High Frequency)**
- **Python (Low Frequency)**
- Golang
- Ruby

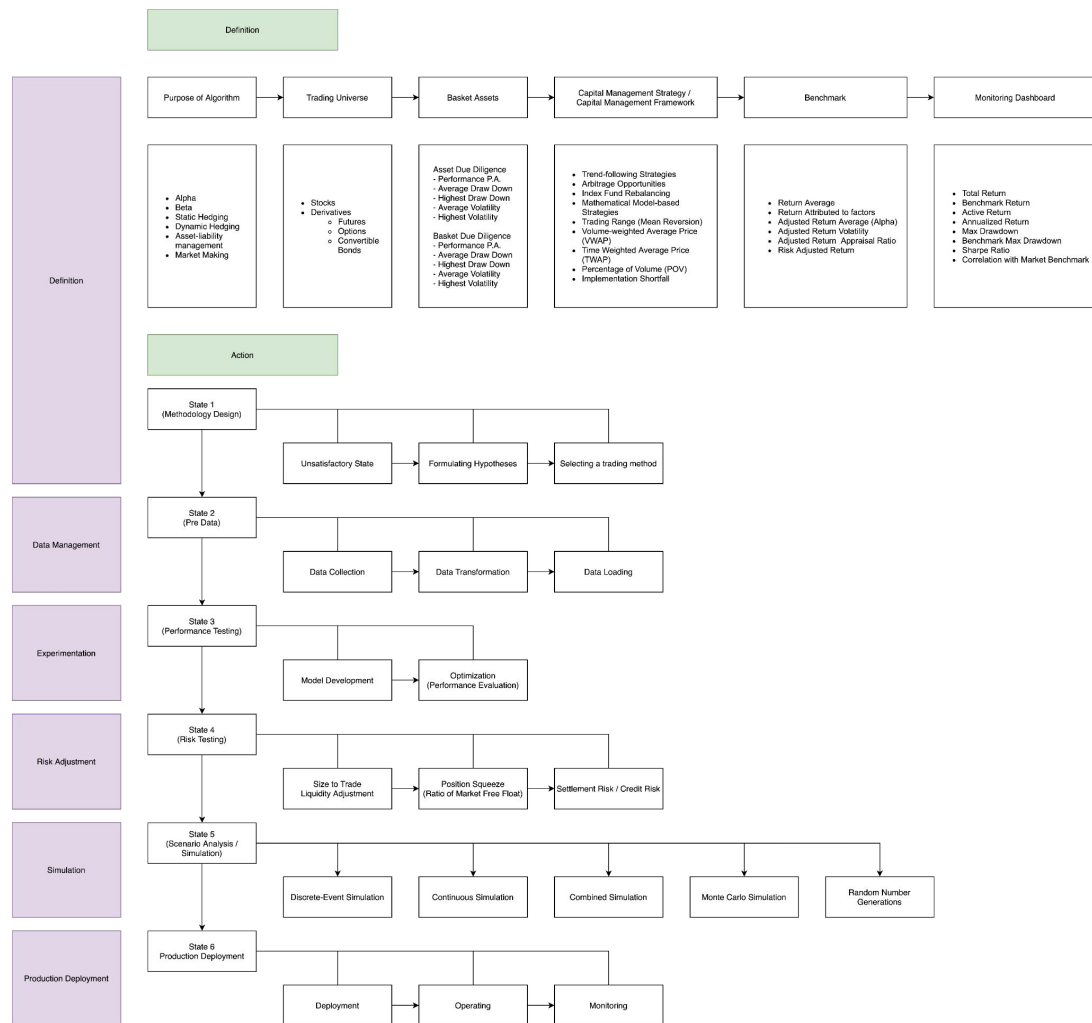
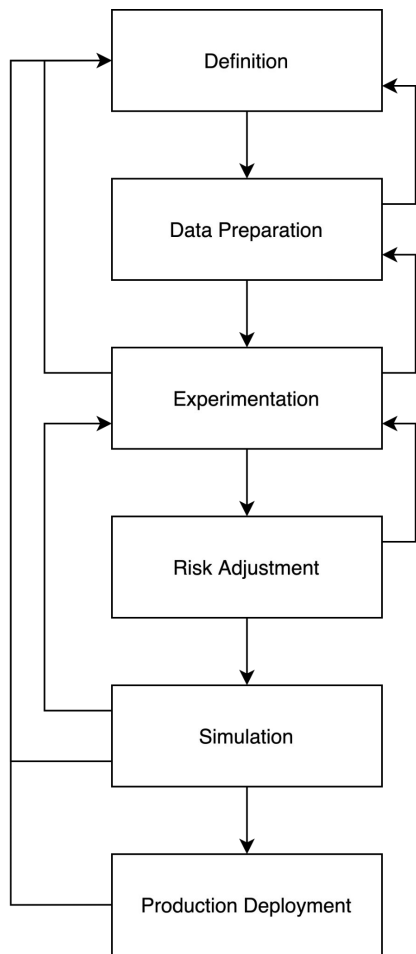
#### Steps of Production

- Plan
- Code
- Build
- Test
- **Release**
- **Deployment**
- **Operating**
- **Monitoring**

### Trading / Financial Markets Knowledge

- Types of Trading Instruments (**Stocks**, Options, Currencies etc.)
- Types of Strategies (Trend Following, Mean Reversal etc.)
- Arbitrage Opportunities
- Options Pricing Models
- Risk Management
- Credit Management / Settlement Risk (Ex. Tether, Other stablecoins)





## Definition

### Purpose of Algorithm

- Alpha
- Beta
- Static Hedging
- Dynamic Hedging
- Asset-liability management
- Market Making

### Trading Universe

- Stocks
- Derivatives
  - Futures
  - Options
  - Convertible Bonds

### Basket Assets

- Asset Due Diliigence
- Performance P.A.
  - Average Draw Down
  - Highest Draw Down
  - Average Volatility
  - Highest Volatility
- Basket Due Diligence
- Performance P.A.
  - Average Draw Down
  - Highest Draw Down
  - Average Volatility
  - Highest Volatility

### Capital Management Strategy / Capital Management Framework

- Trend-following Strategies
- Arbitrage Opportunities
- Index Fund Rebalancing
- Mathematical Model-based Strategies
- Trading Range (Mean Reversion)
- Volume-weighted Average Price (VWAP)
- Time Weighted Average Price (TWAP)
- Percentage of Volume (POV)
- Implementation Shortfall

### Benchmark

- Return Average
- Return Attributed to factors
- Adjusted Return Average (Alpha)
- Adjusted Return Volatility
- Adjusted Return Appraisal Ratio
- Risk Adjusted Return

### Monitoring Dashboard

- Total Return
- Benchmark Return
- Active Return
- Annualized Return
- Max Drawdown
- Benchmark Max Drawdown
- Sharpe Ratio
- Correlation with Market Benchmark

## Purpose of Algorithm

- Alpha
- Beta
- Static Hedging
- Dynamic Hedging
- Asset-Liability Management
- Market Making

Formula for Alpha:

$$\text{Alpha} = \frac{\text{End Price} + \text{DPS} - \text{Start Price}}{\text{Start Price}}$$

**where:**

DPS = Distribution per share



## Formula for Beta

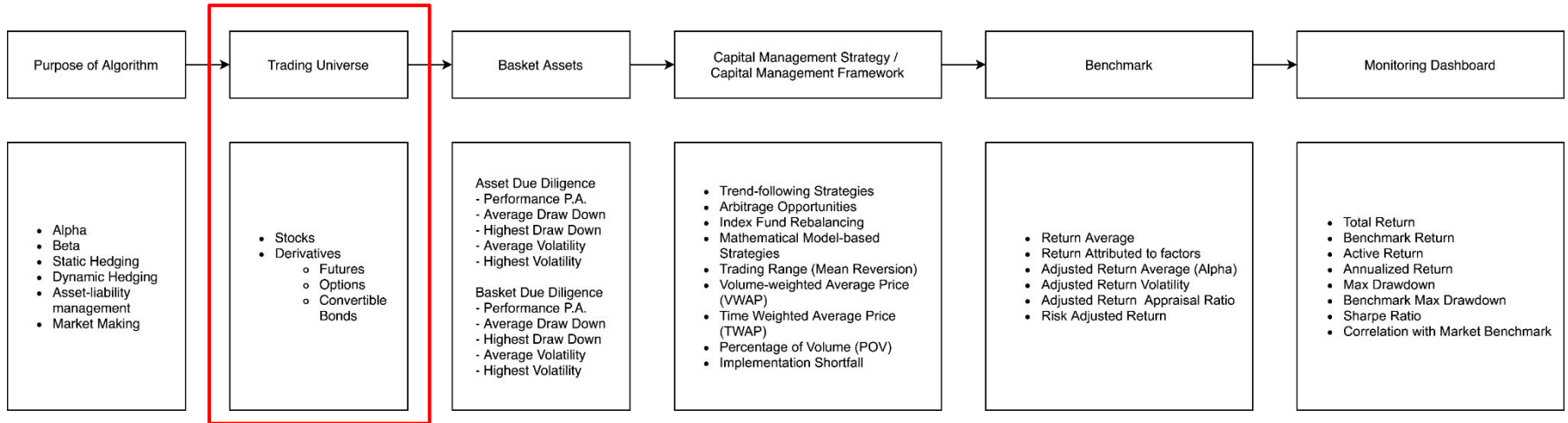
Here is a useful [formula for calculating beta](#):

$$\text{Beta} = \frac{\text{CR}}{\text{Variance of Market's Return}}$$

**where:**

CR = Covariance of asset's return with market's return

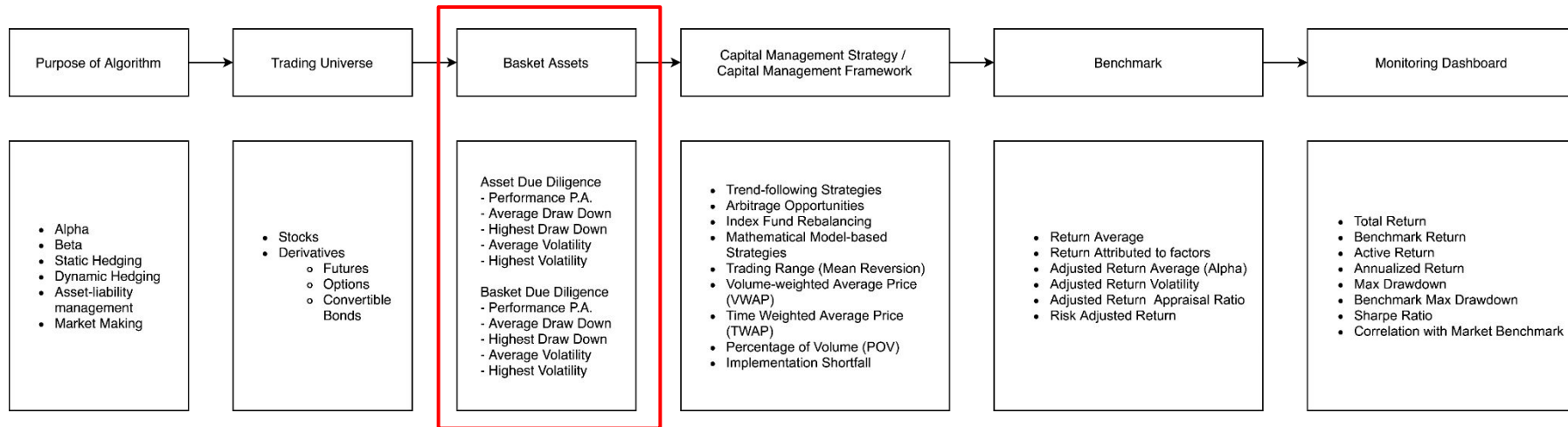
## Definition



# Trading Universe

- Stock
- Derivatives
  - Forward
  - Futures
  - Swap
  - Option
- Bonds
  - Government Bond (2Y 10Y 30Y)
  - Corporate Bond (1Y 2Y 5Y)
  - Convertible Bond (1Y 2Y 5Y), (Junior / Senior)

## Definition



# Basket Assets

## List of Assets

- Stock A
- Stock B
- Stock C
- Stock D
- Stock E
- Stock F
- Stock G
- Stock H

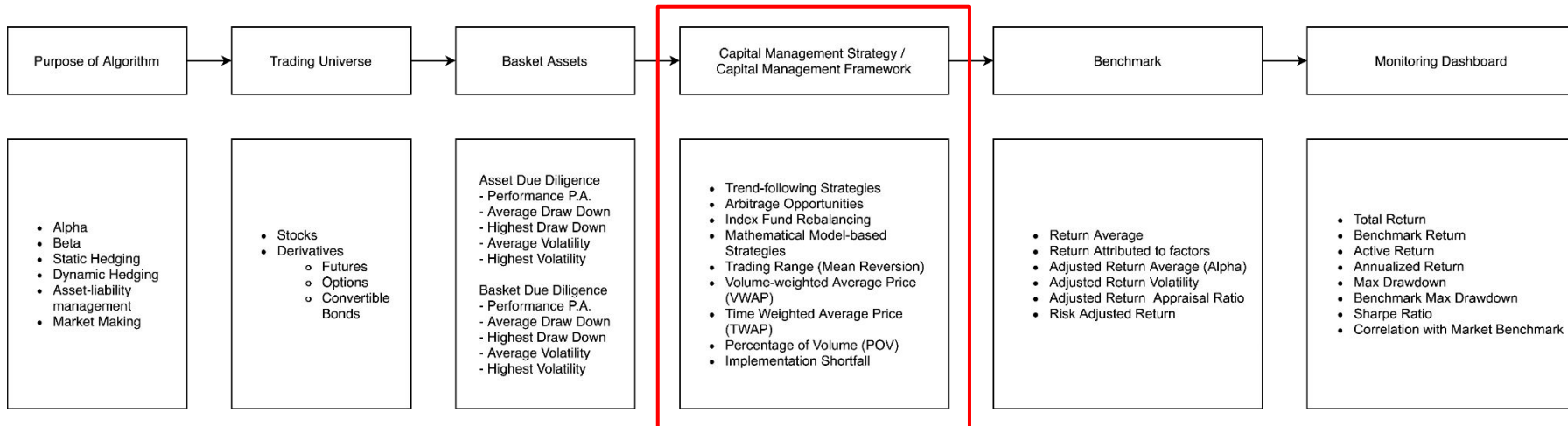
Asset Allocation Design



## Basket Assets

- Stock A
- Stock B
- Stock C
- Stock D

## Definition



Quant	Momentum (time-series or cross-sectional)	Pair-trading, most types of statistical arbitrage	Advanced models (e.g. HMM, regime switching)	HF Market-making, Cash-futures arbitrage	News-based automated trading
Technical	MA cross-over, Continuation patterns	Swing, Retracement, Pivot trading	Opening range, dual thrusts, patterns	Range-based short gamma (vol selling)	Nothing much here
Fundamental	Factor-based investing	value investing	value/ RV (relative value) strategies	Cross-asset, cross country RV/ short gamma	Usually discretionary
	Trending	Mean-reverting	Break-out	Carry	Event-based

# Capital Management Strategy / Framework

## List of Strategies

- Trend-Following
- Absolute Return
- Volume Weight Average Price (VWAP)
- Time Weight Average Price (TWAP)
- Percentage of Volume (POV)

Methodology Design

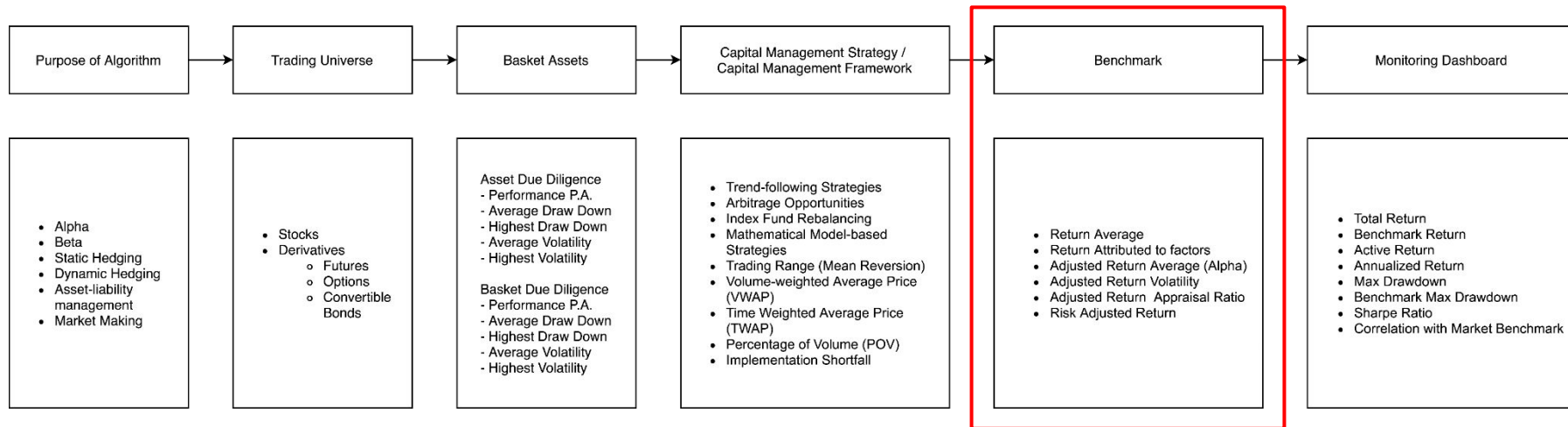


## Main Strategy

- Only single strategy
- Combination of multi strategies



## Definition

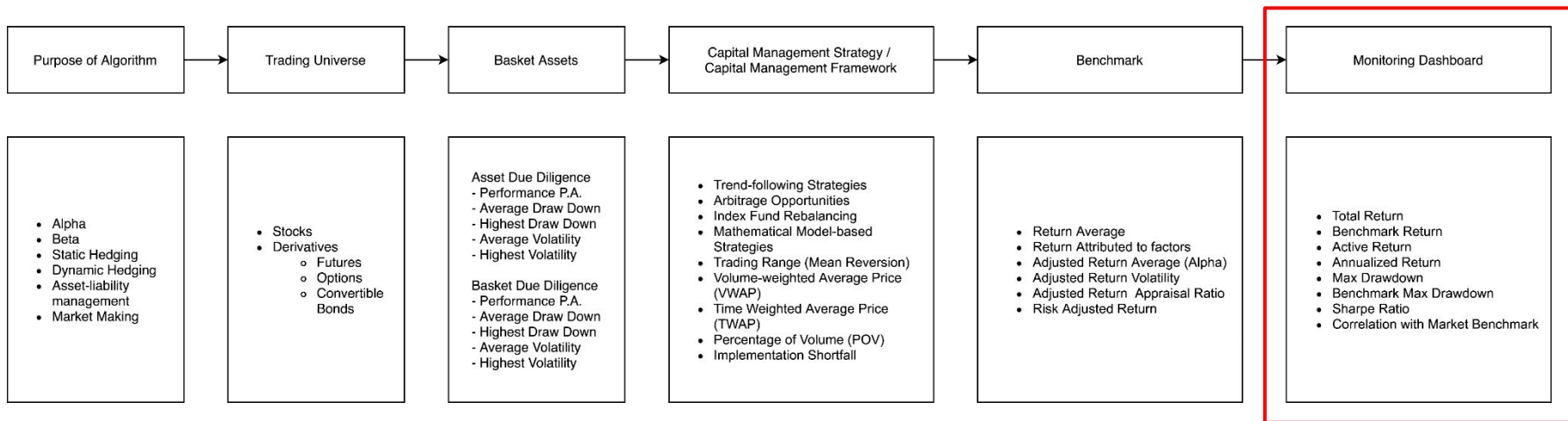


# Benchmark

## List of Benchmarks

- Return Average
- Return Attributed to factors
- **Adjusted Return Average (Alpha)**
- Adjusted Return Volatility
- Adjusted Return Appraisal Ratio
- Risk Adjusted Return

## Definition



# Monitoring Dashboard

## List of Monitoring Factors

- Total Return
- Benchmark Return
- **Active Return (Alpha)**
- **Annualized Return (Alpha/Beta)**
- Max Drawdown
- Benchmark Max Drawdown
- Sharpe Ratio
- Correlation with Market Benchmark

Action

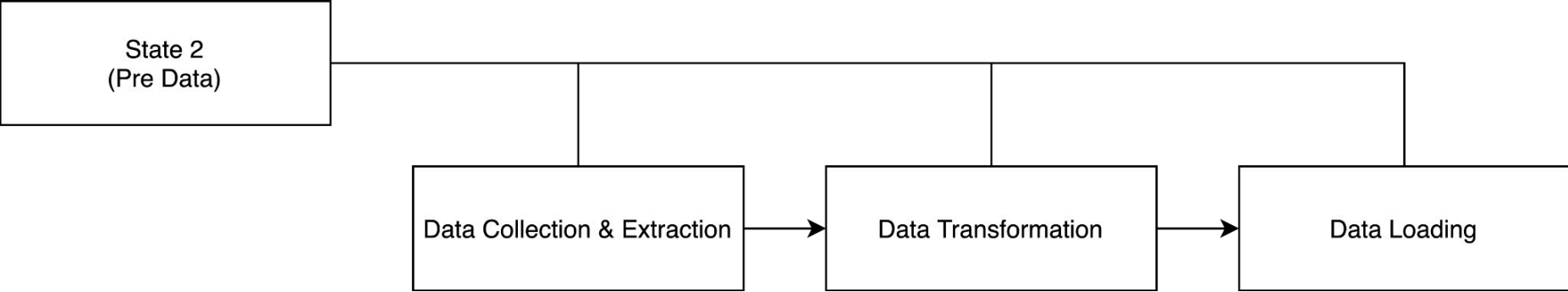
```
graph TD; A[Action]; S1[State 1<br/>(Methodology Design)]; US[Unsatisfactory State]; FH[Formulating Hypotheses]; STM[Selecting a trading method]; S1 --- H1[ ]; S1 --- H2[ ]; S1 --- H3[ ]; H1 --- US; H2 --- FH; H3 --- STM; US --> FH; FH --> STM;
```

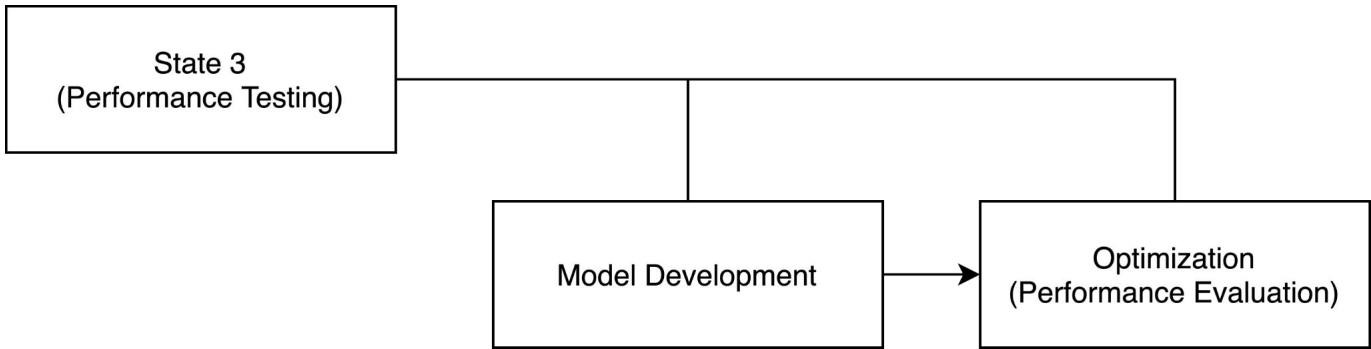
State 1  
(Methodology Design)

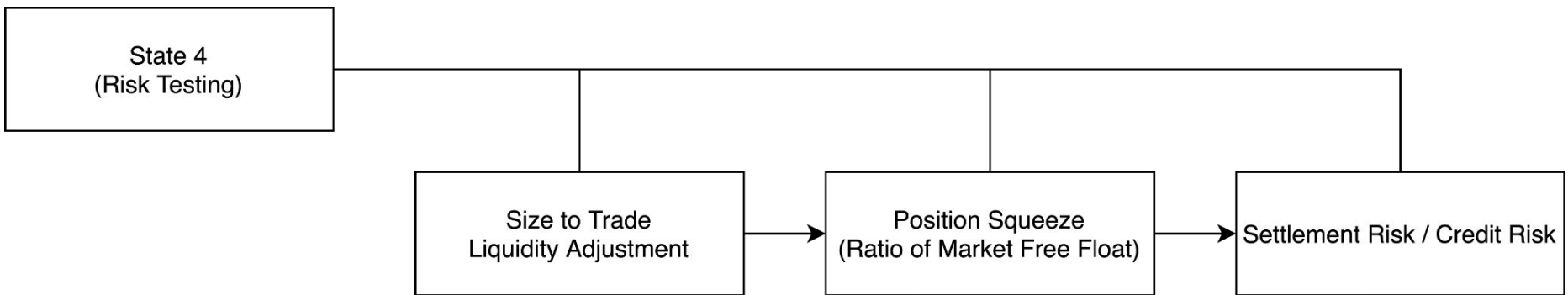
Unsatisfactory State

Formulating Hypotheses

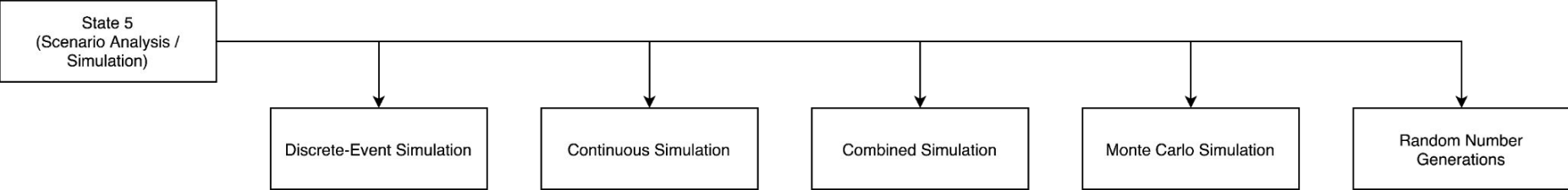
Selecting a trading method

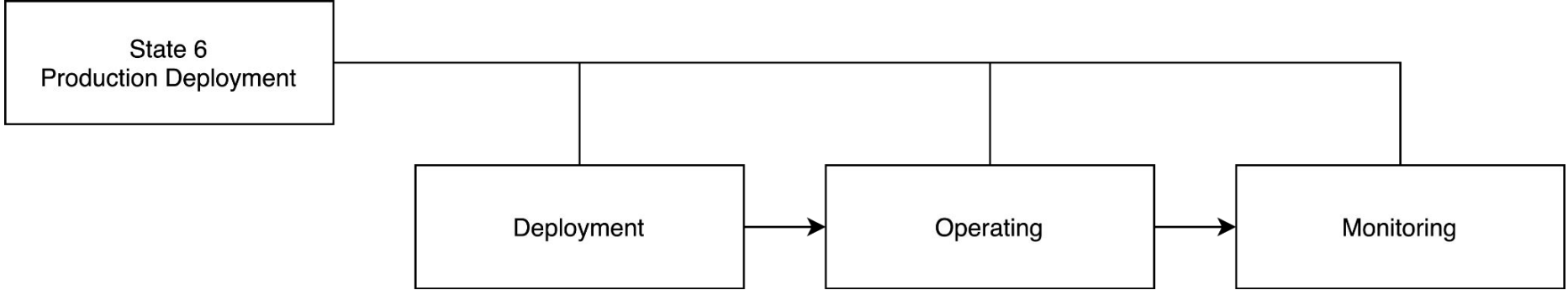








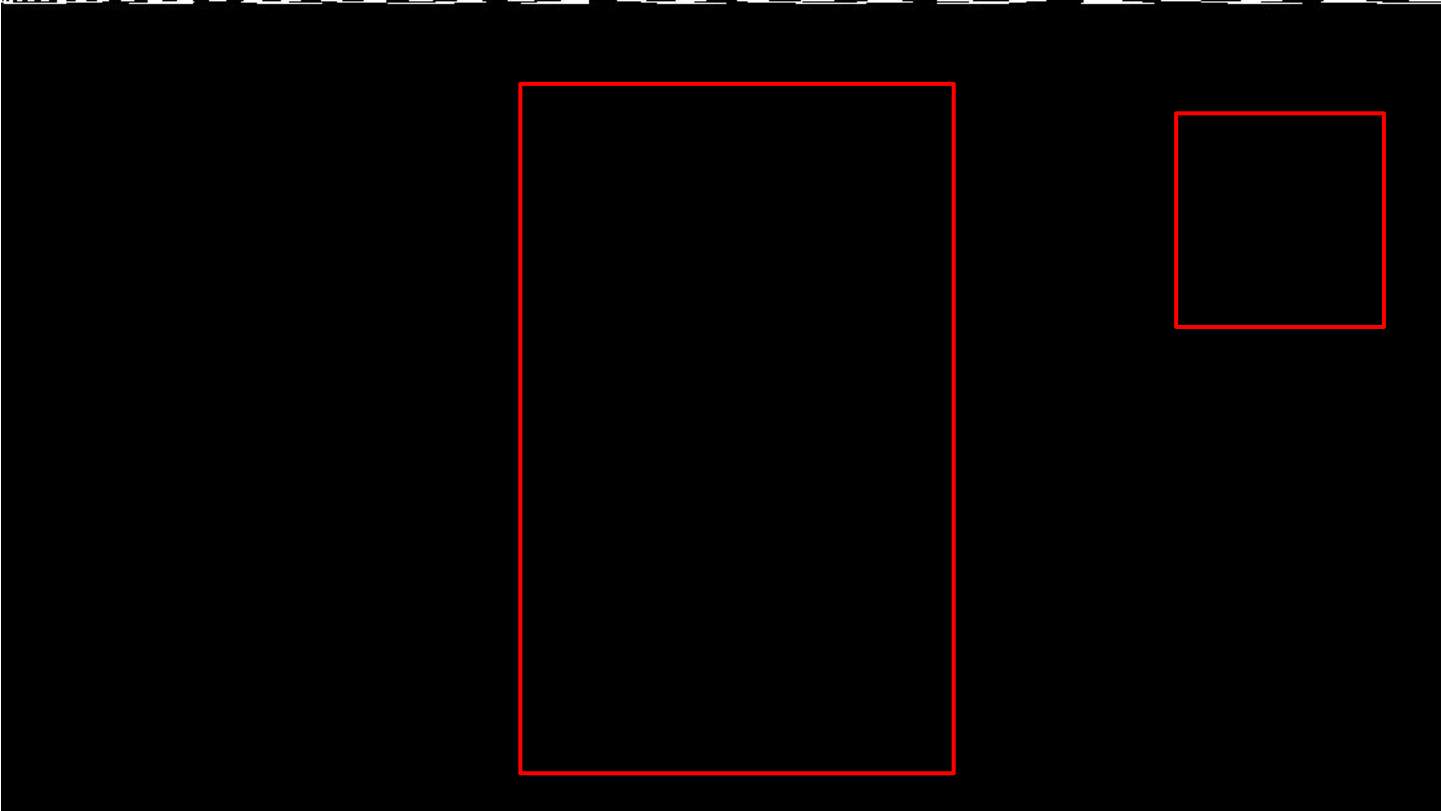




**Static  
Algorithm**

**Dynamic  
Algorithm**









**>> C://Brain/Algorithm/Example Project**



>> C://Brain/Algorithm/**Example Project**

<State0/Define>

>> C://State0Define/1st/Purpose\_of\_Algorithm

>>>Alpha

Beta

Static Hedging

Dynamic Hedging

Asset-Liability Management

Market Making

## >> C://State0Define/2nd/Trading\_Universe

Stock	Stock + Futures + Options	Stock + Options	Crypto Spot
<ul style="list-style-type: none"><li>• MSFT</li><li>• AAPL</li><li>• HK:0700</li><li>• HK:1810</li><li>• IBM</li><li>• JNJ</li><li>• GS</li><li>• TSLA</li></ul>	<ul style="list-style-type: none"><li>• MSFT</li><li>• AAPL</li><li>• HK:0700</li><li>• HK:1810</li><li>• IBM</li><li>• JNJ</li><li>• GS</li><li>• TSLA</li><li>• LONG.SHORT DJI</li><li>• LONG.SHORT NAS</li><li>• Microsoft Call/Put</li></ul>	<ul style="list-style-type: none"><li>• MSFT</li><li>• AAPL</li><li>• HK:0700</li><li>• HK:1810</li><li>• IBM</li><li>• JNJ</li><li>• GS</li><li>• TSLA</li><li>• Microsoft Call/Put</li></ul>	<ul style="list-style-type: none"><li>• Bitcoin (BTC)</li><li>• Ethereum (ETH)</li><li>• Ripple (XRP)</li><li>• Binance (BNB)</li><li>• Cardano (ADA)</li><li>• Polkadot (DOT)</li></ul>

>> C://State0Define/**3rd/Baskets\_Asset**

## Crypto Spot

- 30% Binance (BNB)
- 30% FTX Token (FTT)
- 30% Solana (SOL)
- 10% Cash (USDT or THB)

>> C://State0Define/4th/Capital\_Management\_Framework

## List of Frameworks / Strategies

- Portfolio Rebalanace
- Black-Litterman
- Markowitz
- Value-at-Risk (VaR)
- Blackshore
- Mean Variance Approach
- Capital Asset Pricing Model (CAPM)

>> C://State0Define/5th/Benchmark

## Recommendation Benchmarks

- Adjust Return Average (Alpha)
- Risk Adjusted Return

## Recommendation Tracking Numbers

- Active Return (Alpha)

Total Return - Annualized Return of Holding

- Annualized Return (Alpha/Beta)

>> C://Brain/Algorithm/**Example Project**

<State1/MethodDesign>



>> C://State1MethodDesign/1st/UnsaticfactoryState

>> Set Trading Universe

>> Do Asset Due Diligence

>> Set Boundaries

>> Set List of Benchmarks

>> Set List of Capital Management Strategies

## >> C://State1MethodDesign/2nd/FormulatingHypothesis

### **Hypothesis <MathematicalBased/FundamentalBased>**

- Correlation between assets in longrun, Mean Reversal
- Growth of Users, Tracking by Number of Wallets
- Growth Correlation in Top10 Basket, Top20 Basket, Top50 Basket
- Growth in Price to TransactionCost
- Growth in Price to Sales
- Economy of Scales, Earning Growth Rate
- Substitute good, Price to Volume Impact Assessment

## >> C://State1MethodDesign/3rd/Selecting a trading method

Quant	Momentum (time-series or cross-sectional)	Pair-trading, most types of statistical arbitrage	Advanced models (e.g. HMM, regime switching)	HF Market-making, Cash-futures arbitrage	News-based automated trading
Technical	MA cross-over, Continuation patterns	Swing, Retracement, Pivot trading	Opening range, dual thrusts, patterns	Range-based short gamma (vol selling)	Nothing much here
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>> C://Brain/Algorithm/**Example Project**

**<State2/PreData>**

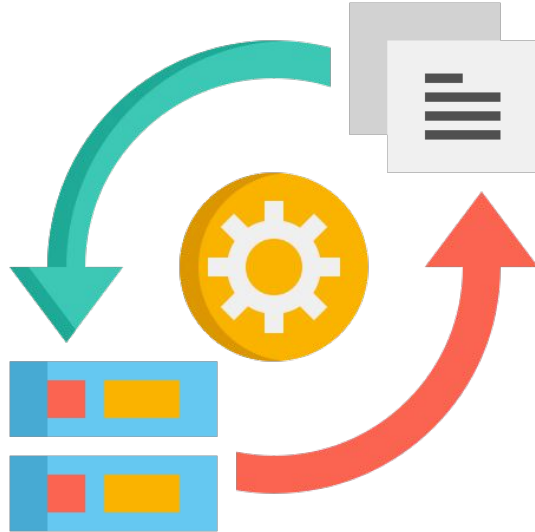
>> C://State2PreData/**1st/DataCollection\_Extraction**

[1] Crawling via API

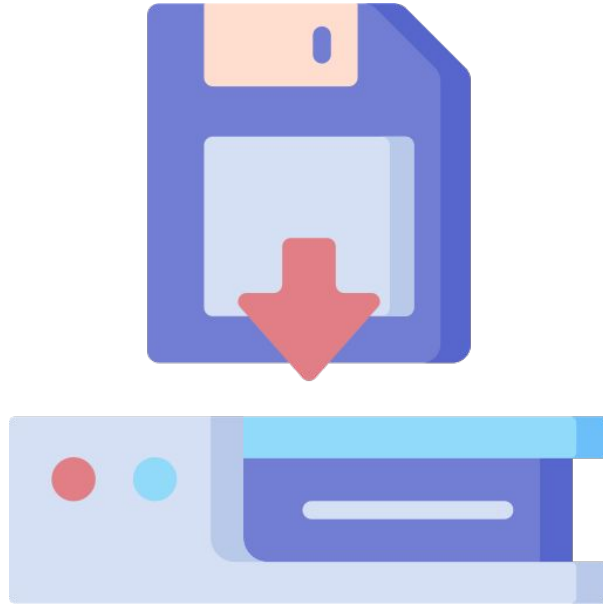
[2] Data Scraping

[3] Manual Data Loading

>> C://State2PreData/**2nd/DataTransformation**



>> C://State2PreData/**3rd/DataLoading**



>> C://Brain/Algorithm/**Example Project**

**<State3/Performance Testing>**

Performance Adjustment



>> C://State3PerformanceTesting/1st/ModelDevelopment

## >> Ratio Allocation

[1] Black Litterman for Asset Allocation (Ratio Management)

[2] Blind Pick

## >> Strategy Testing

[1] Portfolio Rebalancing

[2] Regime Switching

>> C://State3PerformanceTesting/2nd/Optimization

## Optimization

[1] Blind Manual Adjust

**[2] Adjust based on Asset Performance Approach**

[3] Hedging Strategy

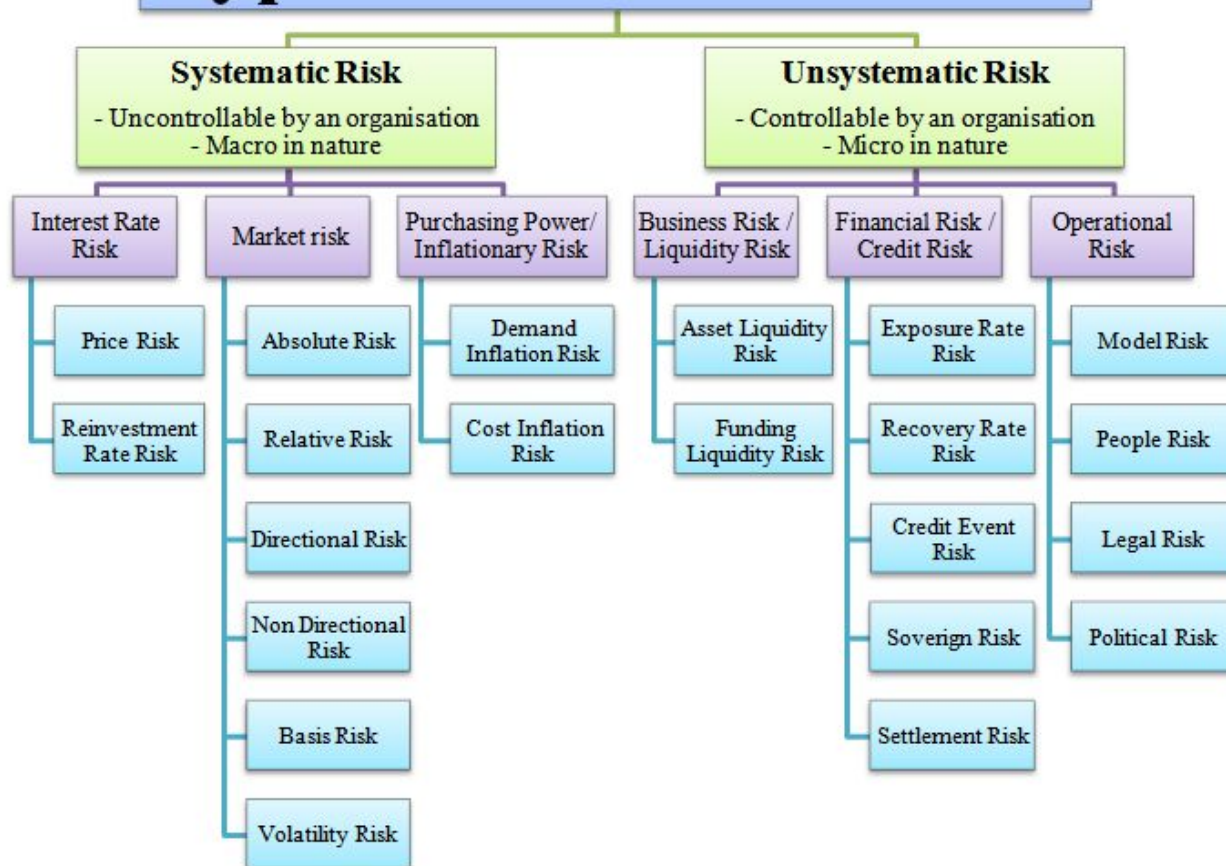
[4] Machine Learning

>> C://Brain/Algorithm/**Example Project**

**<State4/Risk Testing>**

**Risk Assessment**

# Types of Risk in Finance



>> C://State4RiskTesting/**1st/SizeToTrade** (Part of Money Management)

## Betting Position Management

**[1] Kelly Criterion**

**[2] Markowitz**

[3] Martingale

[4] Optimal F

[5] Flat Betting

[6] Sequence Numbers

[7] Natural Number / Fibonacci

>> C://State4RiskTesting/**2nd/PositionSqueeze**

**[1] Securities Borrowing and Lending (SBL)**

**[2] Naked Short Futures / Short Squeeze**

**[3] Options Gamma Squeeze**

[4] Funding Rate Gamma Squeeze

[5] Equity Forwards Squeeze

>> C://State4RiskTesting/**3rd/CreditDefaultRisk**

**[1] Counter Party Risk**

**[2] Asset Backed Risk**

**[3] Credit Event Risk**

**[4] Credit Default Risk**

**[5] Settlement Risk**

[6] Exposure Risk

[7] Recovery Risk

>> C://Brain/Algorithm/**Example Project**

<State5/ScenarioSimulation>



>> C://State5ScenarioAnalysis/**SelectYourMethod >> ???**

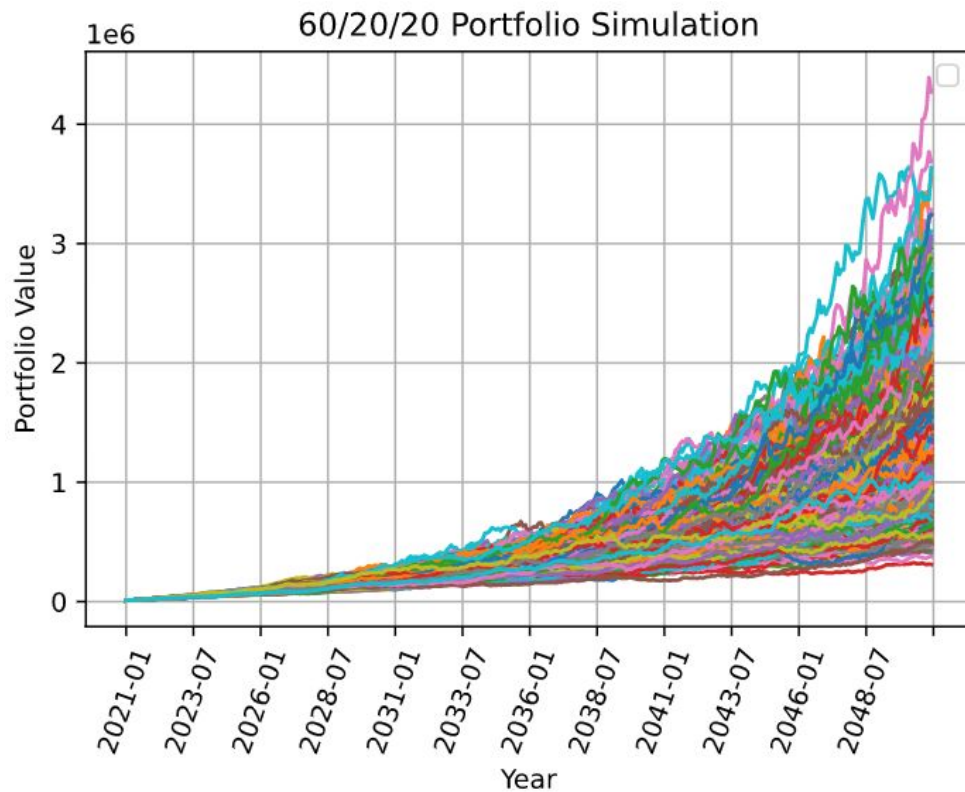
## Scenario Analysis

[1] Worst Scenario Approach (Black Swan)

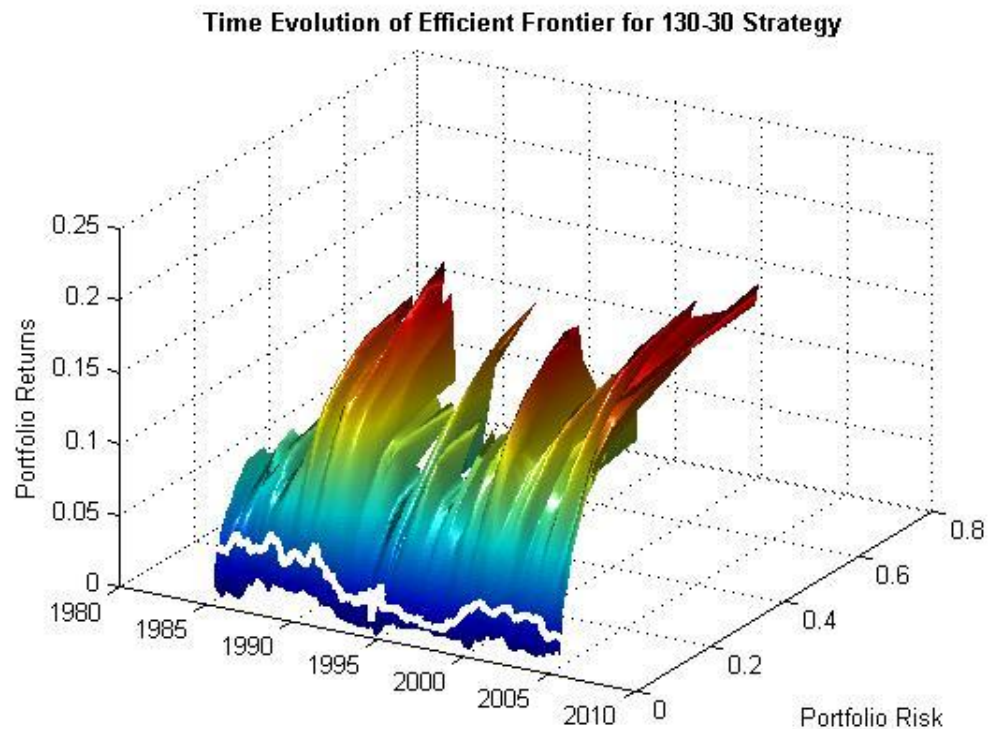
[2] Historical Approach

[3] Stochastic Approach (Probability)

>> C://State5ScenarioAnalysis/**SelectYourMethod>>Monte Carlo**



>> C://State5ScenarioAnalysis/**SelectYourMethod>>Stress Test**



>> C://Brain/Algorithm/**Example Project**

**<State6/ProductionDeployment>**

## >> C://State6ProductionDeployment/Deployment

[1] Processing Pipeline

- ❖ Source
- ❖ Build
- ❖ Pre Test
- ❖ Deploy
- ❖ Post Test

[2] Code Analysis

[3] Intregation/API Tests

[4] Smoke Test

[5] Regression Tests / Visual Regression Tests

**\*\*\* Heap Memory for Python Developer  
>> Solution: Garbage Collection**

>> C://State6ProductionDeployment/**Operating**

[1] Version Control

[2] Build

[3] Unit Test

[4] Deploy to Test

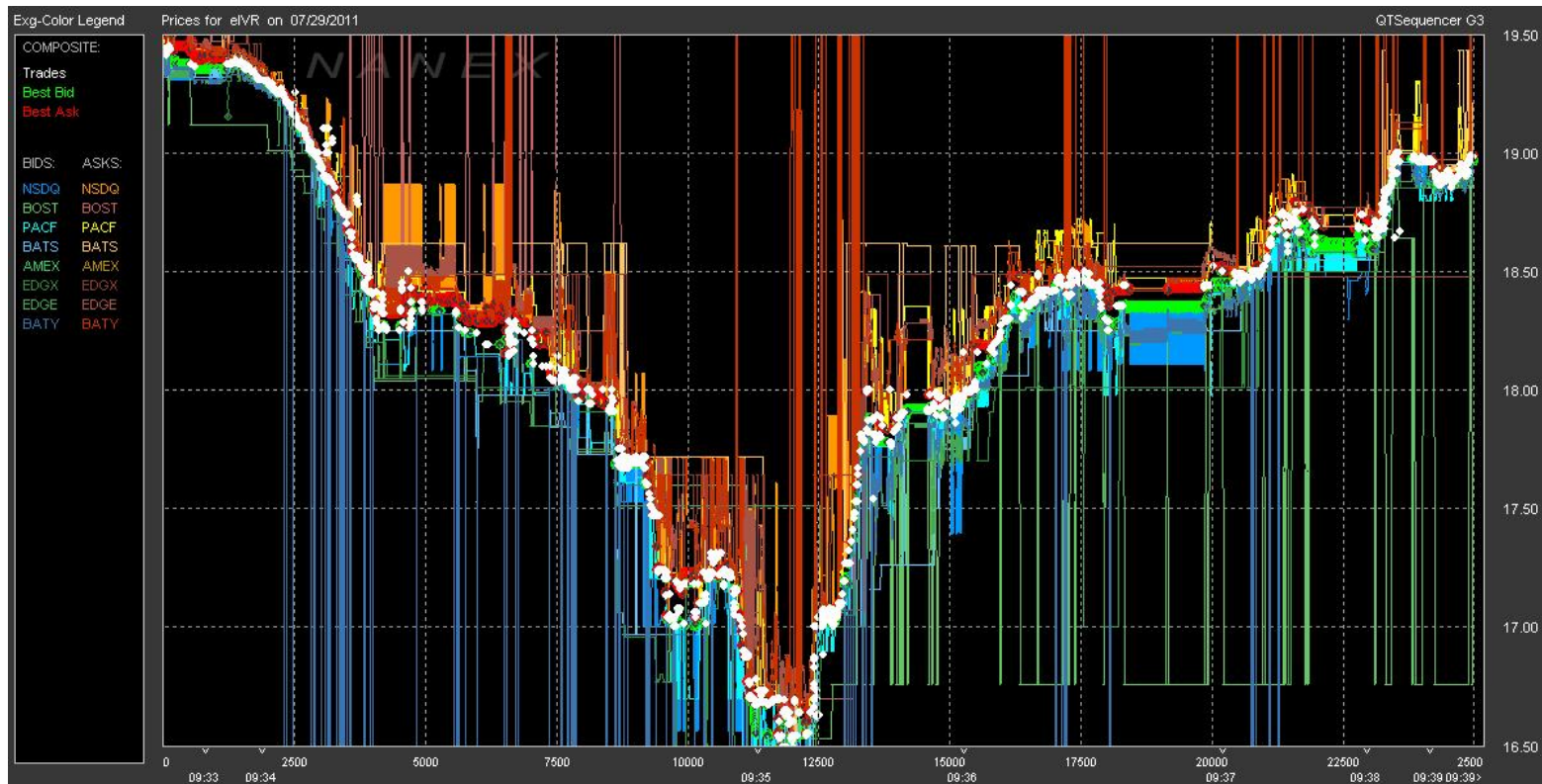
[5] Auto Test

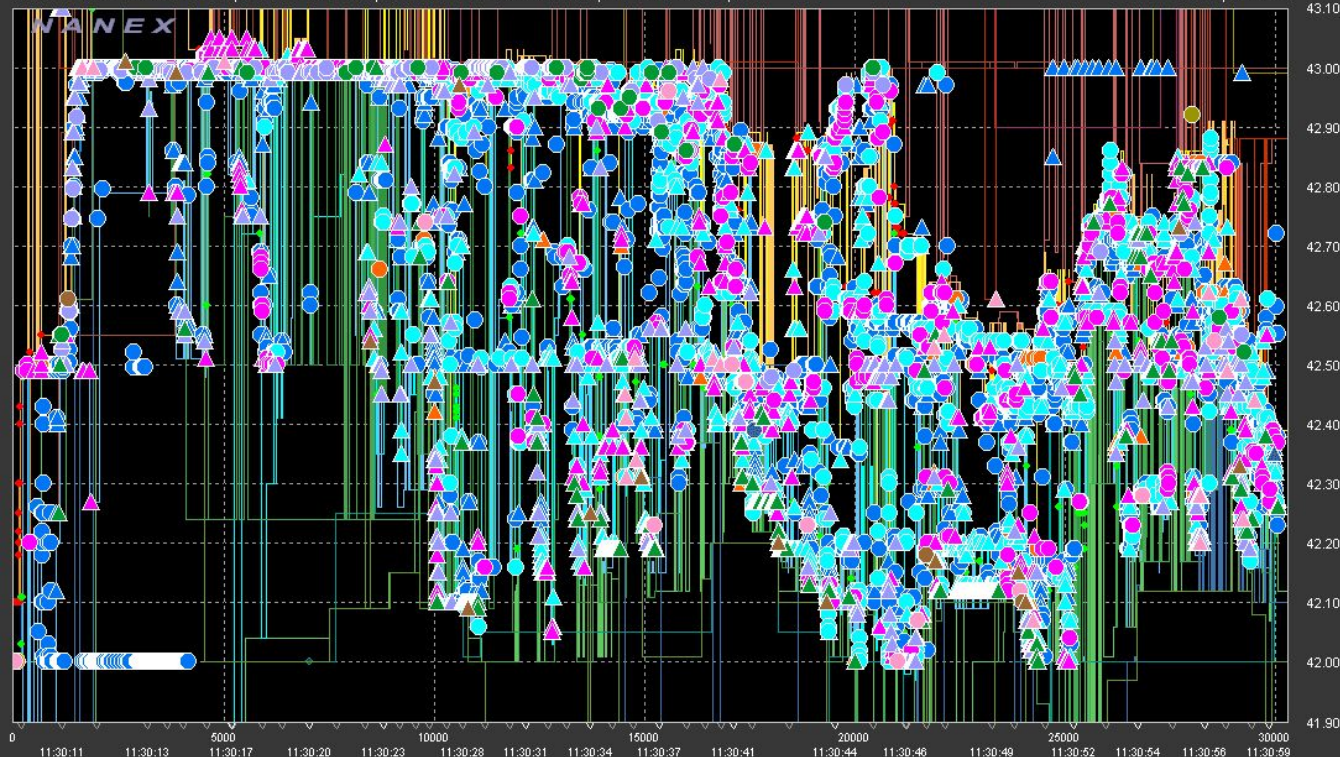
[6] Deploy to Production

[7] Measure + Validate

[8] Feedback for Experimentation

>> C://State6ProductionDeployment/Monitoring>>HFT





ColorLgnd				Reporting Exg Stats			Composite/NBBO	
Trd	ISO	Bid	Ask	Exg	# Quotes	# Trades		
●	▲	■	■	NSDQ	2,821	10,691	●	National Best Bid
●	▲	■	■	BOST	855	251	●	National Best Ask
●	▲	■	■	PACF	2,644	3,715		
●	▲	■	■	BATS	2,713	2,050		
●	▲	■	■	CINC	58	5		
●	▲	■	■	CBCE	0	1		
●	▲	■	■	EDGX	1,300	970		
●	▲	■	■	EDGE	355	1,037		
●	▲	■	■	BATV	115	77		
●	▲	■	■	PHIL	75	30		



# Monitoring Dashboard

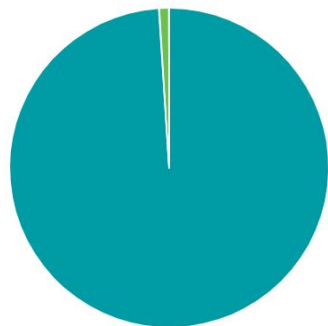
# RATIO INFORMATION



	1 y		3 y	
Volatility	12.29		11.60	
Alpha	-6.13		1.03	
Beta	0.40		0.43	
Sharpe	0.32		0.00	
Info Ratio	-1.61		-0.08	
R <sup>2</sup>	0.53		0.62	
Quartiles	1	2	3	4

Ratio Criteria ?

[View other funds in the sector](#)

# ASSET CLASS BREAKDOWN (30/06/2021)



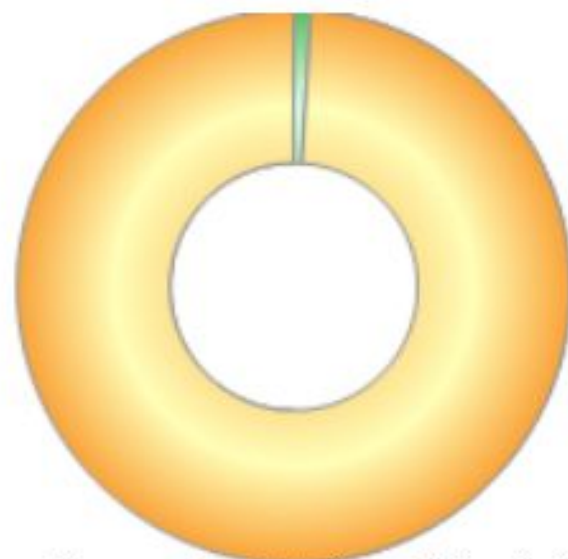
Rank	Asset	%
1	 International Equities	99.00
2	 Money Market	1.00

# TOP HOLDINGS (30/06/2021)

Rank	Largest Holdings	%
1	DIAGEO	6.10
2	UNILEVER PLC	5.40
3	RECKITT BENCKISER GROUP PLC	5.10
4	RELX PLC	5.00
5	EXPERIAN PLC	4.80
6	PAYCHEX, INC.	3.60
7	ASTRAZENECA PLC	3.50
8	NESTLE SA	3.40
9	GLAXOSMITHKLINE	3.40
10	CRODA INTERNATIONAL PLC	3.30

## Asset Allocation (30 Jun 2021)

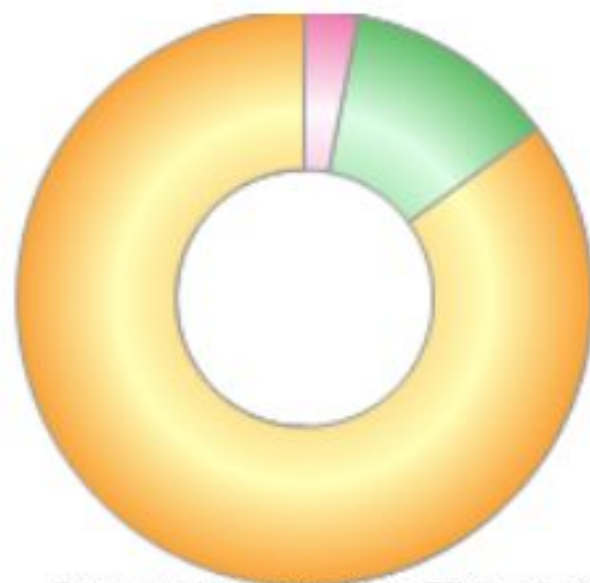
Rank	Asset Classes	%
1	Equities	99.00
2	Cash	1.00



Powered by data from FE fundinfo

## Regional Breakdown (30 Jun 2021)

Rank	Regions	%
1	GB	85.00
2	US	12.00
3	CH	3.00



Powered by data from FE fundinfo

## Sector Breakdown (30 Jun 2021)

Rank	Sectors	%
1	Consumer Staples	26.00
2	Financials	18.00
3	Industrials	14.00
4	Consumer Discretionary	12.00
5	Health Care	9.00
6	Real Estate	6.00
7	Information Technology	6.00
8	Materials	6.00
9	Utilities	2.00
10	Cash	1.00



Powered by data from FE fundinfo

# Citadel's Risk Center

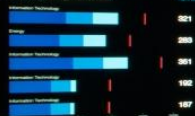
## Fund Level

Spot Risk

4.4%

LOWER 5.0% UPPER 7.8%

## Equity Exposures



## Currency Exposures



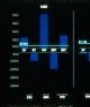
## Fixed Income

Spot Risk

369

LOWER 427 UPPER 49

## Interest Rate Exposures



## Global Factor Risk



## Asia Factor Risk



## L/S Equities

Spot Risk

386

LOWER 427 UPPER 49

## Spot Risk



## Spot Risk



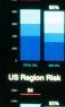
## Spot Risk



## US Region Risk



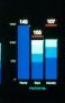
## US Region Risk



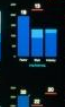
## US Region Risk



## US Region Risk



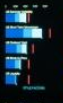
## US Region Risk



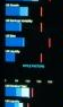
## US Region Risk



## US Region Risk



## US Region Risk



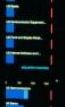
## US Region Risk



## US Region Risk



## US Region Risk



## US Region Risk



## US Region Risk



## US Region Risk



## US Region Risk



## US Region Risk



## US Region Risk



## US Region Risk



## Commodities

Spot Risk

180

LOWER 184 UPPER 248

## Exposures



## Credit



## Portfolio Exposures



## Spot Risk



## Spot Risk



## Spot Risk



## Spot Risk



## Transactions



## System Status









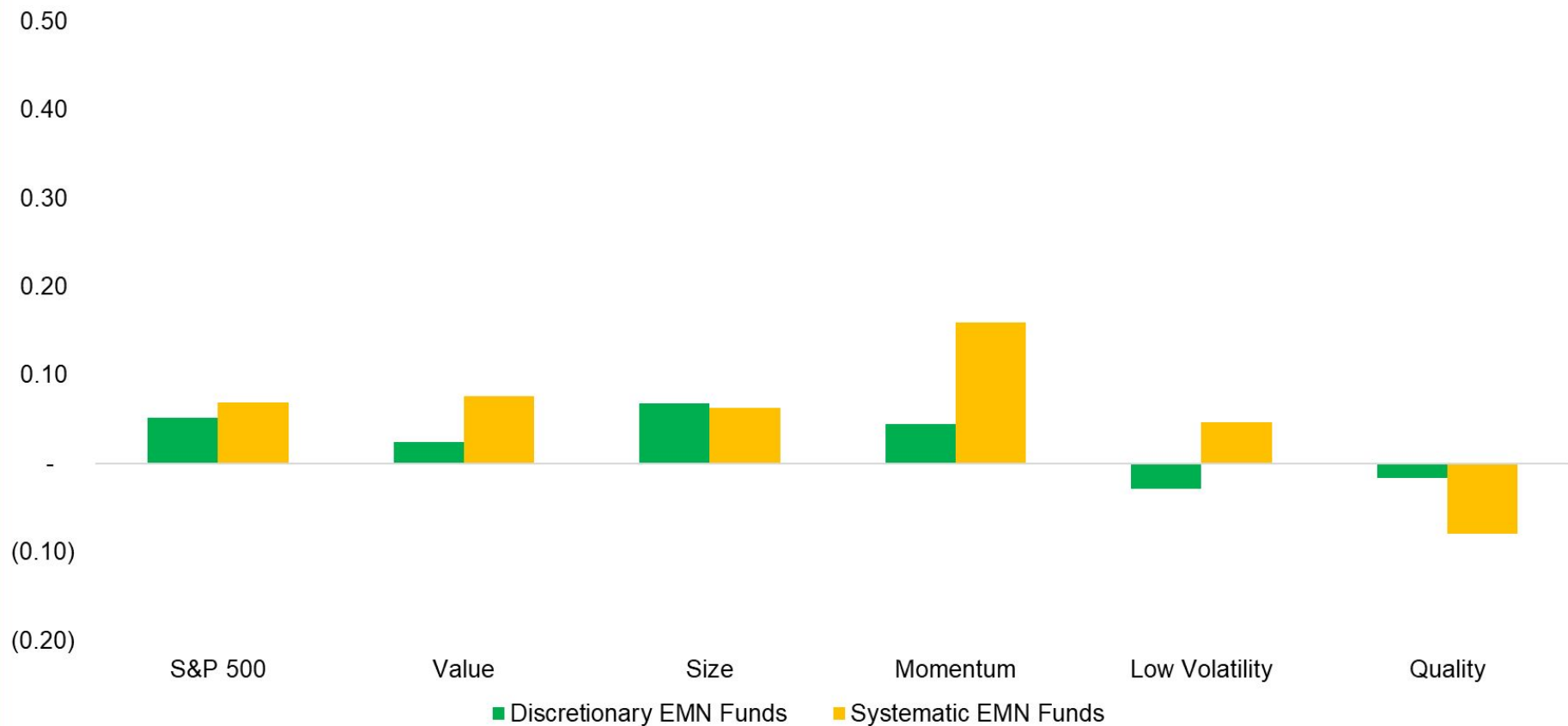
# Discretionary

Discretionary strategy allows the trader to make the final call on price and time.

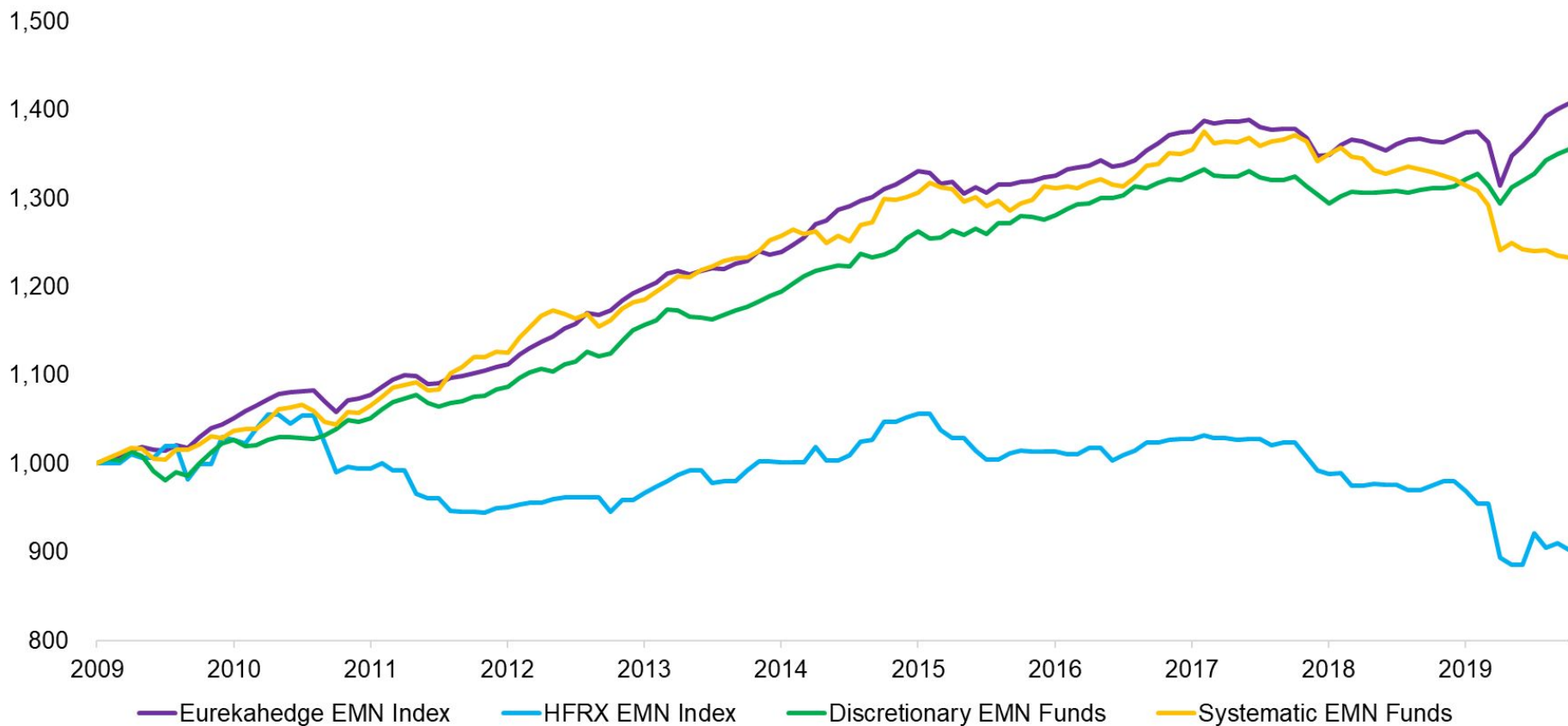
# Systematic

Systematic strategy generate a definitive trading signal

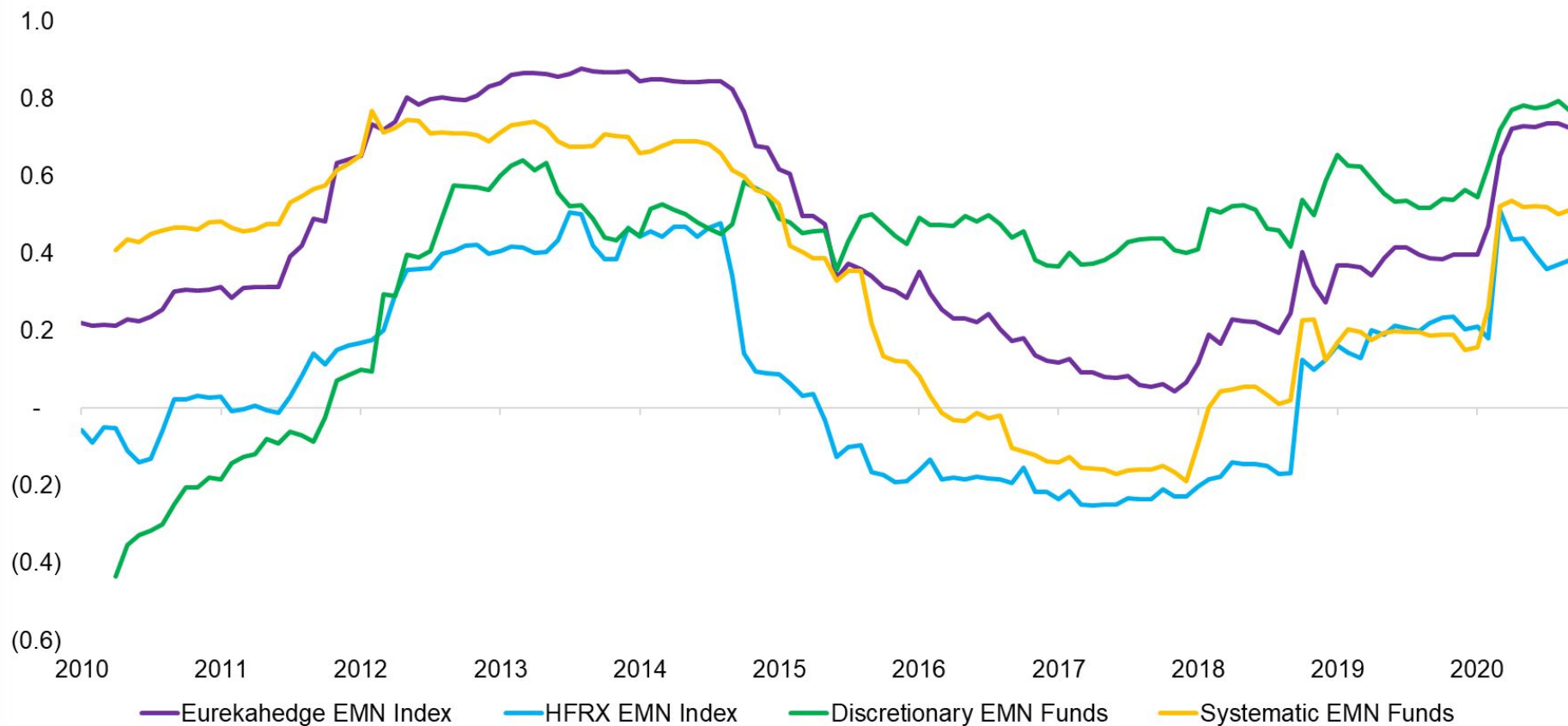
Equity Market Neutral (EMN) Hedge Funds: Factor Exposure Analysis (2009 - 2020)



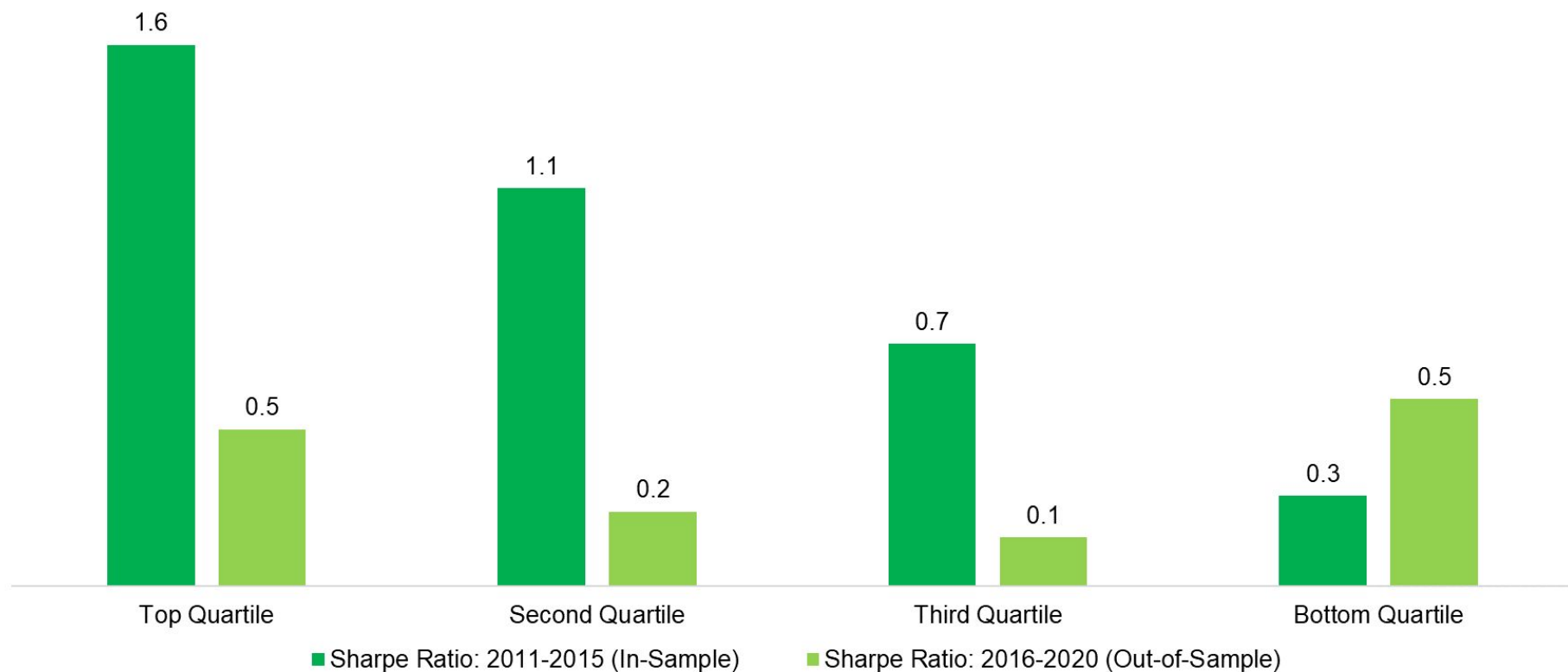
## Equity Market Neutral (EMN) Hedge Funds: Highlighting Survivorship Bias



Equity Market Neutral (EMN) Hedge Funds: Correlations to the S&P 500

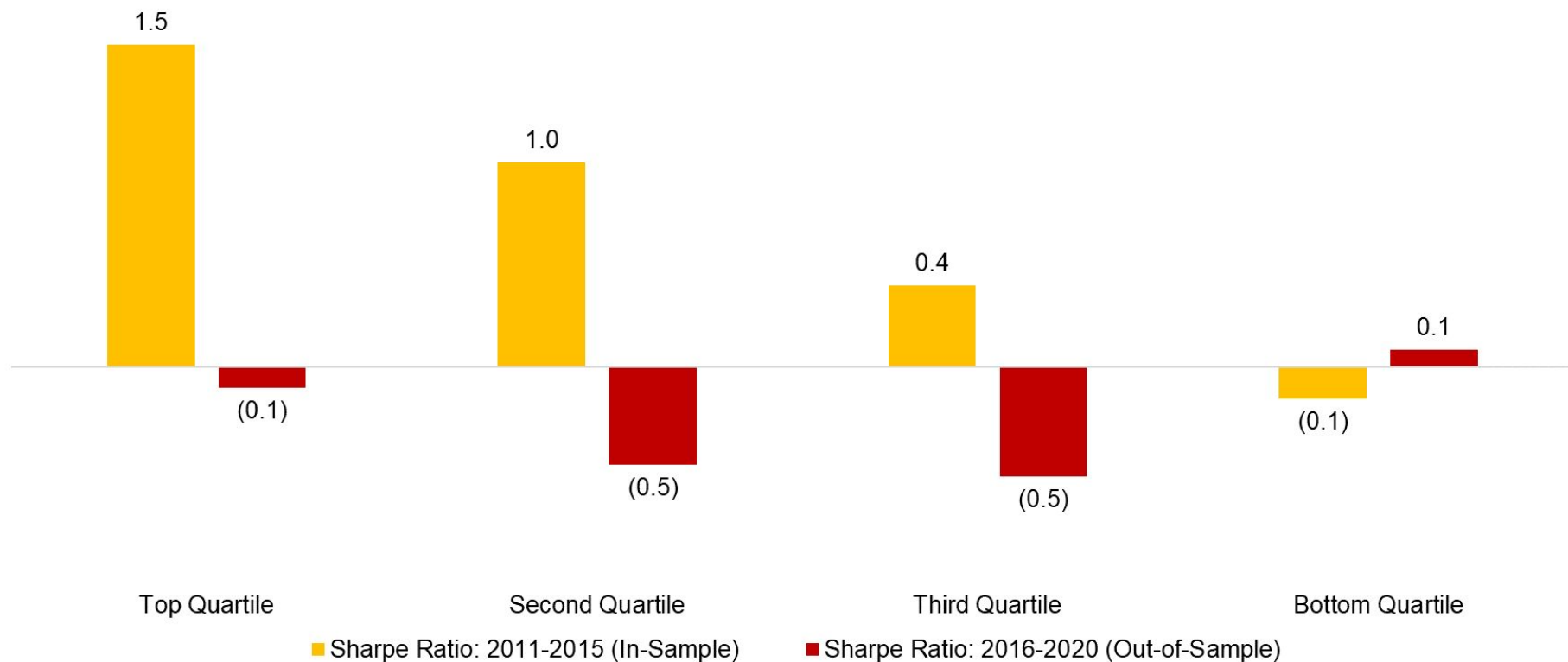


## Performance Consistency of Discretionary Equity Market Neutral Hedge Funds





## Performance Consistency of Systematic Equity Market Neutral Hedge Funds





>> C://END