HERIOT WATT UNIVERSITY

FHDW Fachhochschule der Wirtschaft

Automating Robustness Analysis of Trading Strategy Development Processes

DBA research by Edwin Stang

June 2021: Work in Progress

Supervisors:

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LEADERS IN IDEAS AND SOLUTIONS

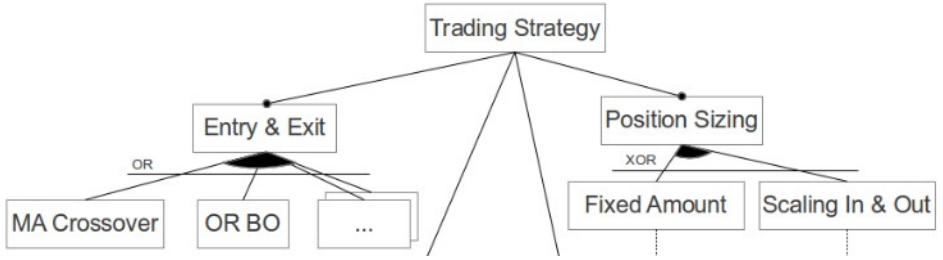
Agenda

Automate Trading Strategy Development

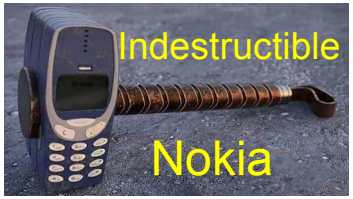
1. Simulate a Team of Random Developers

Source: https://suekatz.typepad.com/.a/6a00d8341c7a9753ef016302a844f5970d-popup

2. Formalise Decision Points



3. Automated Longitudinal Study
4. Measure Robustness of the Process



Source: https://knowyourmeme.com/memes/subcultures/indestructible-nokia-3310

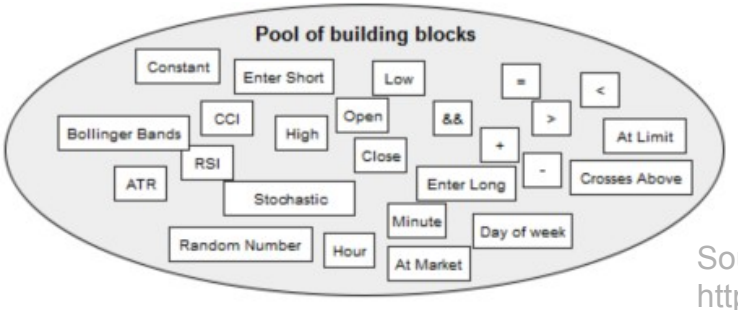
1.1. Process Overview

Strategy Generator

Expression Language

Robustness Validation

UIs for Explainable AI

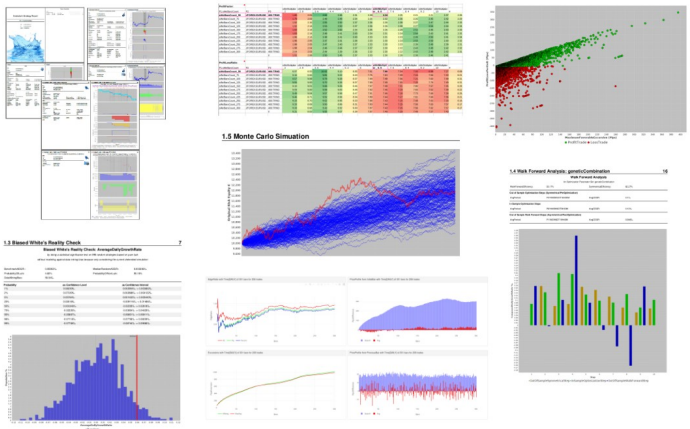


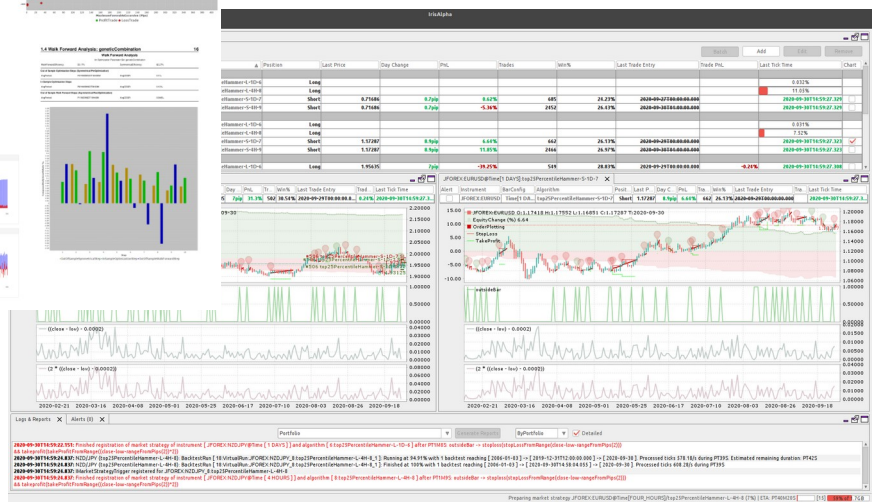
Source: https://www.strategyquant.com/licenses/d?code=sqxug

Example of randonly generated entry rule:

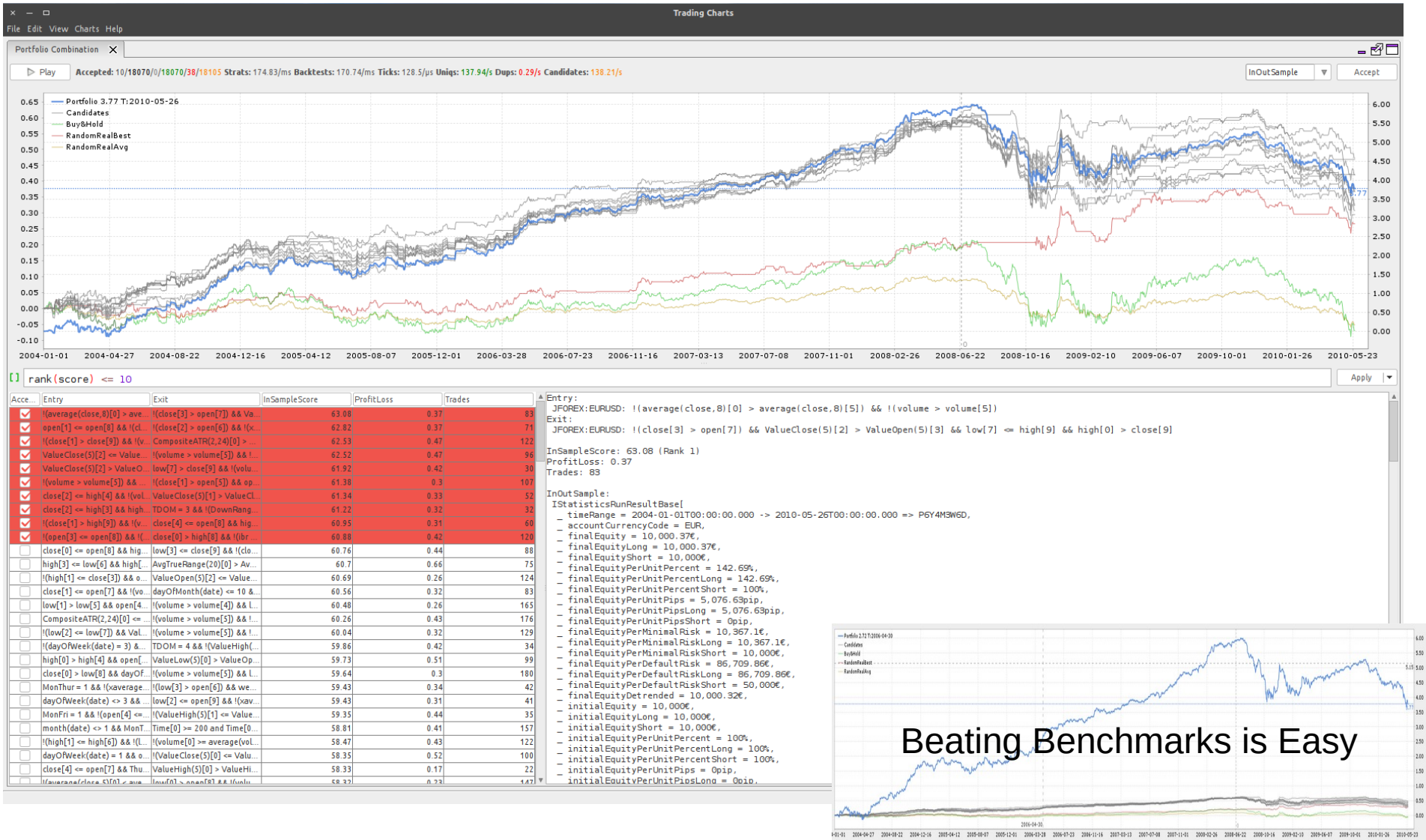
CCI	60	>	0	&&	Day of week	<>	Monday	Enter Long	At Market

if (CCI(60) > 0 && Day of week <> Monday) then Enter Long At Market





1.2. Portfolio Selector



Acce...	Entry	Exit	InSampleScore	ProfitLoss	Trades
☑	!(average(close,8)[0] > ave...	!(close[3] > open[7]) && Va...	63.08	0.37	83
☑	open[1] <= open[8] && !(cl...	!(close[2] > open[6]) && !(x...	62.82	0.37	71
☑	!(close[1] > close[9]) && !(v...	CompositeATR(2,24)[0] > ...	62.53	0.47	122
☑	ValueClose(5)[2] <= Value...	!(volume > volume[5]) && !...	62.52	0.47	96
☑	ValueClose(5)[2] > ValueO...	low[7] > close[9] && !(volu...	61.92	0.42	30
☑	!(volume > volume[5]) && ...	!(close[1] > open[5]) && op...	61.38	0.3	107
☑	close[2] <= high[4] && !(vol...	ValueClose(5)[1] > ValueCl...	61.34	0.33	52
☑	close[2] <= high[3] && high...	TDOM = 3 && !(DownRang...	61.22	0.32	32
☑	!(close[1] > high[9]) && !(v...	close[4] <= open[8] && hig...	60.95	0.31	60
☑	!(open[3] <= open[8]) && !(...	close[0] > high[8] && !(ibr ...	60.88	0.42	120
☐	close[0] <= open[8] && hig...	low[3] <= close[9] && !(clo...	60.76	0.44	88
☐	high[3] <= low[6] && high[...	AvgTrueRange(20)[0] > Av...	60.7	0.66	75
☐	!(high[1] <= close[3]) && o...	ValueOpen(5)[2] <= Value...	60.69	0.26	124
☐	close[1] <= open[7] && !(vo...	dayOfMonth(date) <= 10 &...	60.56	0.32	83
☐	low[1] > low[5] && open[4...	!(volume > volume[4]) && l...	60.48	0.26	165
☐	CompositeATR(2,24)[0] <= ...	!(volume > volume[5]) && !...	60.26	0.43	176
☐	!(low[2] <= low[7]) && Val...	!(volume > volume[5]) && !...	60.04	0.32	129
☐	!(dayOfWeek(date) = 3) &...	TDOM = 4 && !(ValueHigh(...	59.86	0.42	34
☐	high[0] > high[4] && open[...	ValueLow(5)[0] > ValueOp...	59.73	0.51	99
☐	close[0] > low[8] && dayOf...	!(volume > volume[5]) && l...	59.64	0.3	180
☐	MonThur = 1 && !(xaverage...	!(low[3] > open[6]) && we...	59.43	0.34	42
☐	dayOfWeek(date) <> 3 && ...	low[2] <= open[9] && !(xav...	59.43	0.31	41
☐	MonFri = 1 && !(open[4] <=...	!(ValueHigh(5)[1] <= Value...	59.35	0.44	35
☐	month(date) <> 1 && MonT...	Time[0] >= 200 and Time[0...	58.81	0.41	157
☐	!(high[1] <= high[6]) && !(l...	!(volume[0] >= average(vol...	58.47	0.43	122
☐	dayOfWeek(date) = 1 && o...	!(ValueClose(5)[0] <= Valu...	58.35	0.52	100
☐	close[4] <= open[7] && Thu...	ValueHigh(5)[0] > ValueHi...	58.33	0.17	22
☐	!(average(close,5)[0] < ave...	low[0] > open[8] && !(volu...	58.32	0.23	147

1.3. Enhanced Capabilities

- **Fast Expression Language**

Based on:

- **PARSII:** 28.3 ms
- **EXPR:** 37.2 ms
- **MathEval:** 7748.5 ms
- **JEP:** 647.0 ms
- **MESP:** 220.8 ms
- **JFEP:** 274.3 ms

Source: http://andreas.haufler.info/2013/12/how-to-write-one-of-fastest-expression.html

```
close() > 3.14 && (2 + (7 - 5) * 3.14159 * pow(close(),
   (12-10)) + sin(-3.141)) > 1000
```

Backtests:

Variation	New	Parsii
Parsing, 1 Thread	22.51/ms	3.70/ms
Parsing, 12 Threads	122.50/ms	21.25/ms
Caching, 1 Thread	60.94/ms	4.35/ms
Caching, 12 Threads	432.73/ms	24.79/ms

New is Faster:

6x Parser

17x Execution

with Information Compression:

Variation	Backtests	Decisions
Caching, 1 Thread	223.31/ms	1202.55/µs
Caching, 12 Threads	1488.04/ms	8013.07/µs

60x Execution

- **Allows Testing Processes, not just Strategies**
  - **4x to 8x** Faster than Fastest Alternative

    (140k to 1.6 million Backtests per Second)
  - Alternatives offer only Entry/Exit Decision Points in Cross Sectional Studies without Significance Test

2.1. Decision Points I

Strategy

- **Data Preprocessors**: Aggregate, Modify, Randomize Data
- **Entry**: avg(25) > avg(5) && indicator(2) > 20
- **Exit**: !entry || stopLoss(volatility(14)*2)

Risk

- **Order Type**: <entry> && enterLongAtLimit(volatility(14)*2)
- **Money Management / Position Sizing**:
  - Fixed Amount, Weighted, Markowitz, OptimalF, …
- **Equity Curve Trading**:
  - lossTradesToday < 3 && equityRiskPercent < 30

2.2. Decision Points II

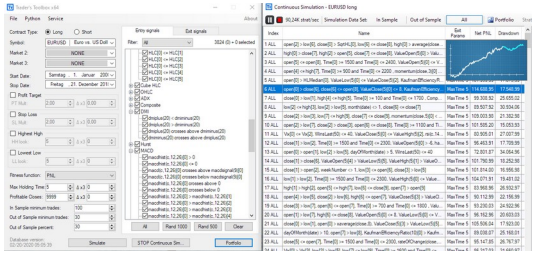
Higher Level

- **Strategy/Portfolio Selection**:
  - rank(os_profitLoss) <= 10 && profitLoss > 0
- **Nested Optimisation**:
  - avg(optimise(start=20, min=5, max=50, step=5)) > avg(5)
- **Robustness Checking**:
  - walkForwardEfficiencyPercent > 50
  - monteCarloDrawdownPercent(confidence=0.95) < 15

3.1. Signal vs Breakout Strategies

- Signal Strategies: Filter only
  - Entry: enterLongAtMarket(Signal1 && Signal2 && Signal3 && Signal4)
  - Exit: exit(Signal5 && Signal6 && Signal7 && Signal8)
  - Inspired by BuildAlpha

    (Source: https://www.buildalpha.com/)



- Breakout Strategies: Price Target
  - Entry: FilterLong && enterLongAtStop(LongPriceLevel + Volatility * Factor)
    || FilterShort && enterShortAtStop(ShortPriceLevel - Volatility * Factor)
  - Exit: exitOnClose
  - Inspired by BetterTraderAcademy

    (Source: https://www.bettertraderacademy.com/)

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3.2. Test Setup

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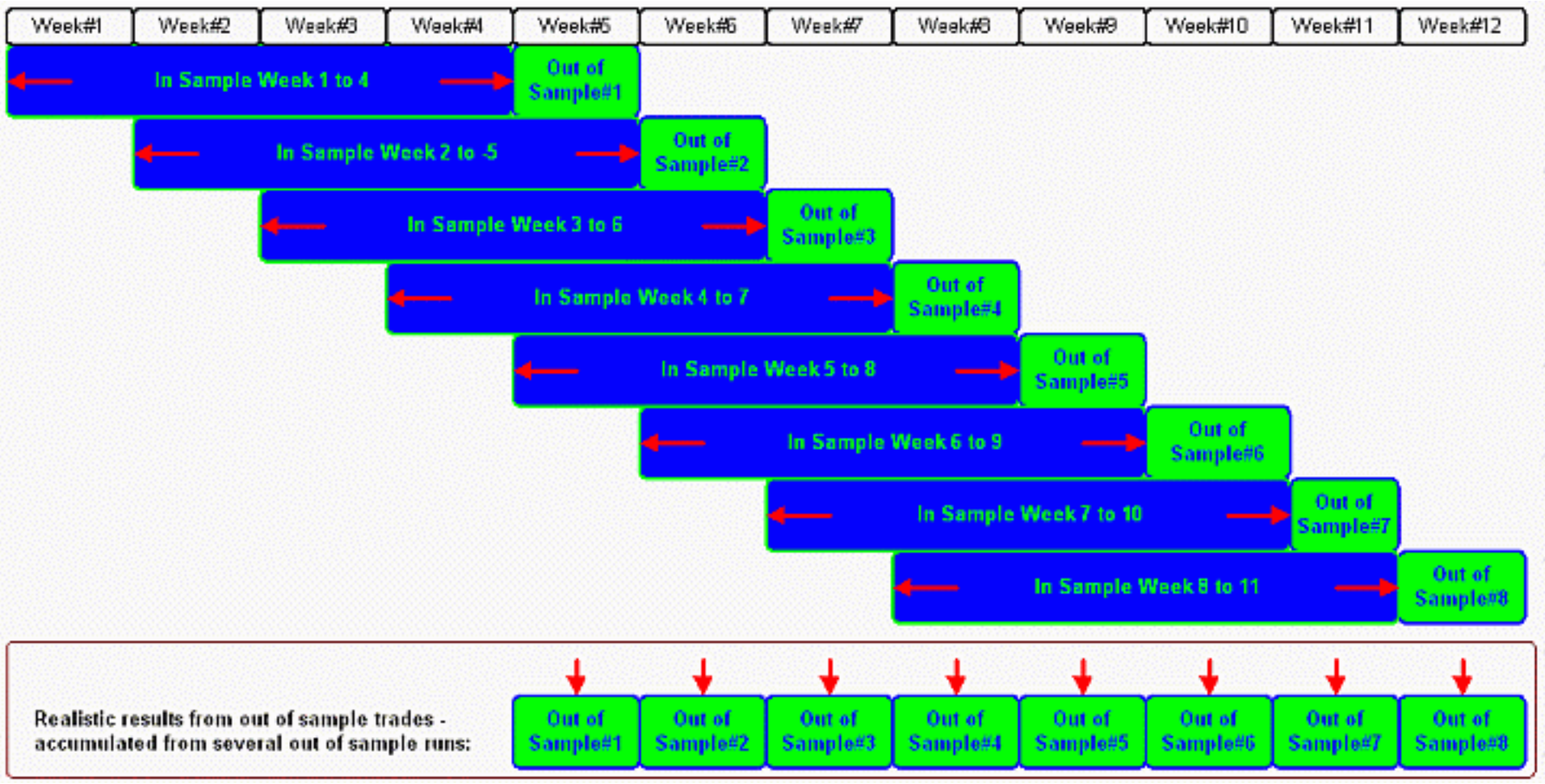
- **Foreign Exchange Market**: EUR/USD
- **Commission:** Dukascopy Broker
  (Source: https://www.dukascopy.com/swiss/english/about/fee-schedule/)
- **Bars[Open, High, Low, Close]**: Daily → Time[1 DAY]
- **Order Types**: [Market] vs [Stop, Limit, StopLimit, MarketIfTouched]
- **Positions**: [Long] vs [Long || Short]
- **Money Management**: FixedAmount(minLot)
- **Strategy Filter**: rank(inSampleProfitLoss) <= 10
- **Walk Forward Analysis**:
  - 6 Years IN Samples; 1 Year OUT Samples
  - 10 Steps from 2010 to 2020

Manually Simplified Process

3.3. Walk Forward Analysis



Source: https://blackwellglobal.com/mt4-walk-forward-optimisation/

4.1. Test Results: ProfitLoss

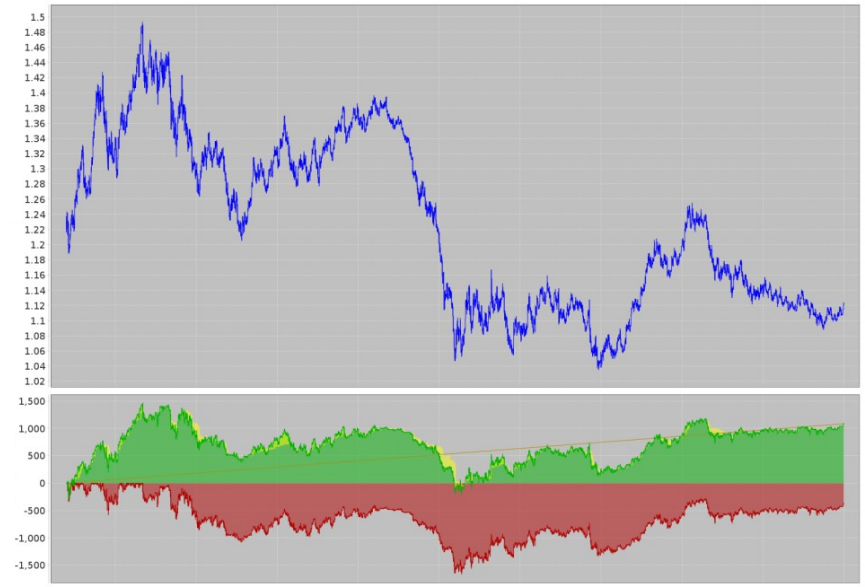
Signal

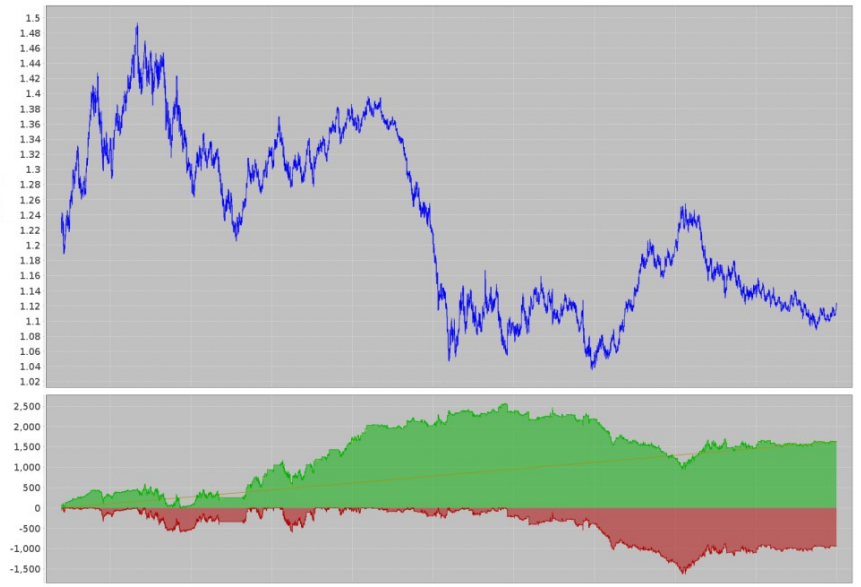
EUR/USD (€/$)

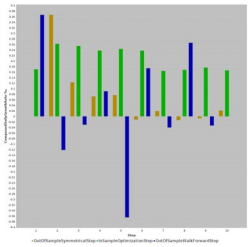
Breakout

Price

Loss/Profit





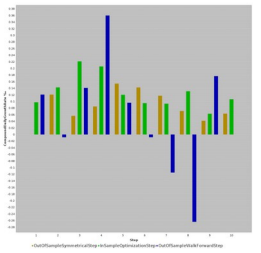


16.42%

WalkForwardEfficiency =

OutOfSampleProfit / InSampleProfit

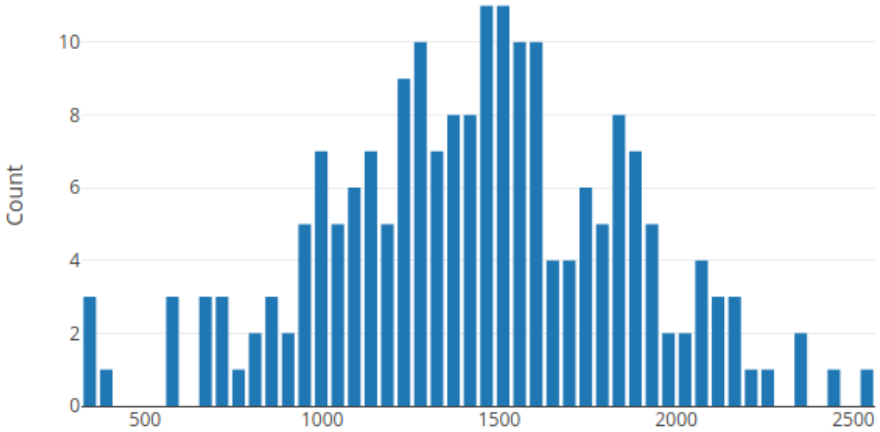
43.4%



4.2. Test Results: Stability

200 Monte Carlo Runs

Signal

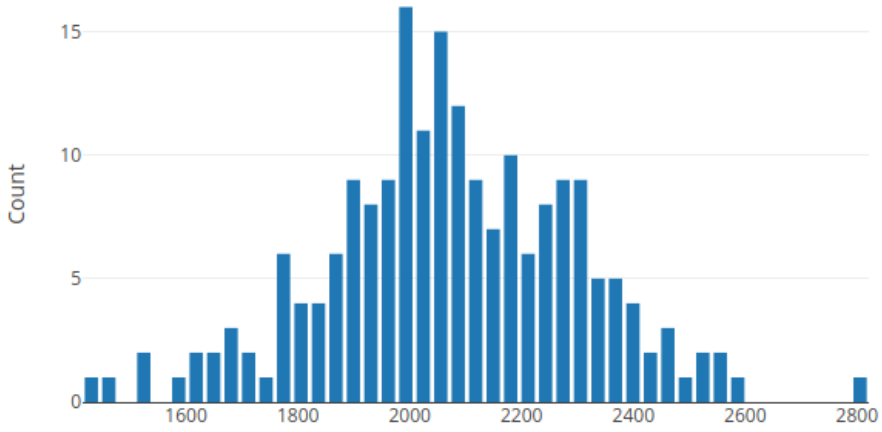


Confidence Level	ProfitLoss
1%	2528.84000
25%	1739.11000
50%	1452.83000
75%	1159.93000
99%	362.11000
Avg	1439.32300
Range	2335.25000
IQ-Range	579.18000

Variability is Larger

>

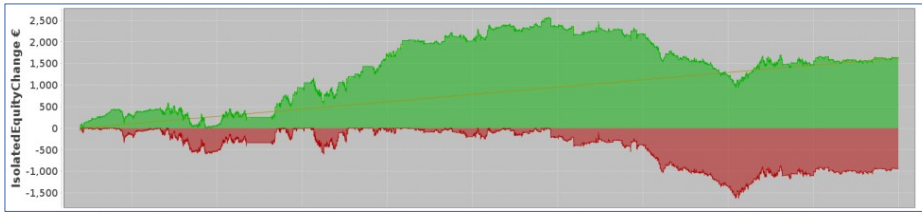
Breakout



Confidence Level	ProfitLoss
1%	2811.01000
25%	2249.46000
50%	2062.98000
75%	1942.70000
99%	1513.90000
Avg	2078.13455
Range	1562.26000
IQ-Range	306.76000

4.3. Breakout Order Types

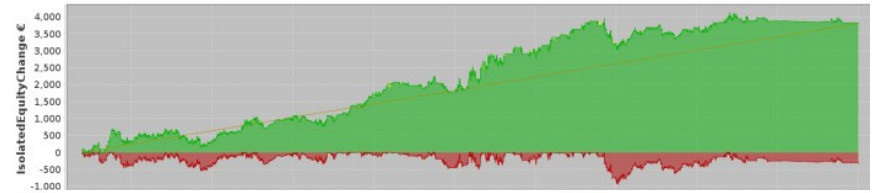
All Strategies Together



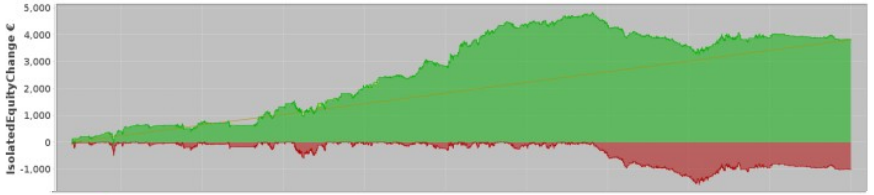
[Stop, Limit, StopLimit, MarketIfTouched]

WalkForwardEfficiency 43.4%

Good Component Strategies

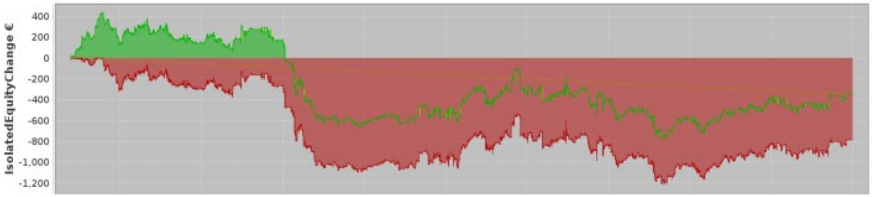


[Stop] 119.1%

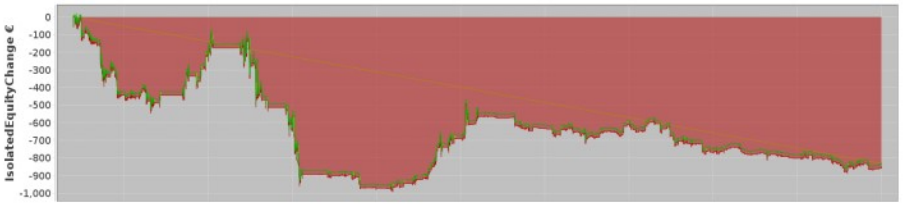


[Limit] 93.08%

Bad Component Strategies



[StopLimit] -16.82%



[MarketIfTouched] -60.76%

Next Research Question:
Which process can reduce false positives without my human bias?
Automate the process further...

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Thank You for Your Attention!

Further Questions?

Requests:
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