MC^2: a cryptocurrency portfolio solution

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MC² Mission

Problem

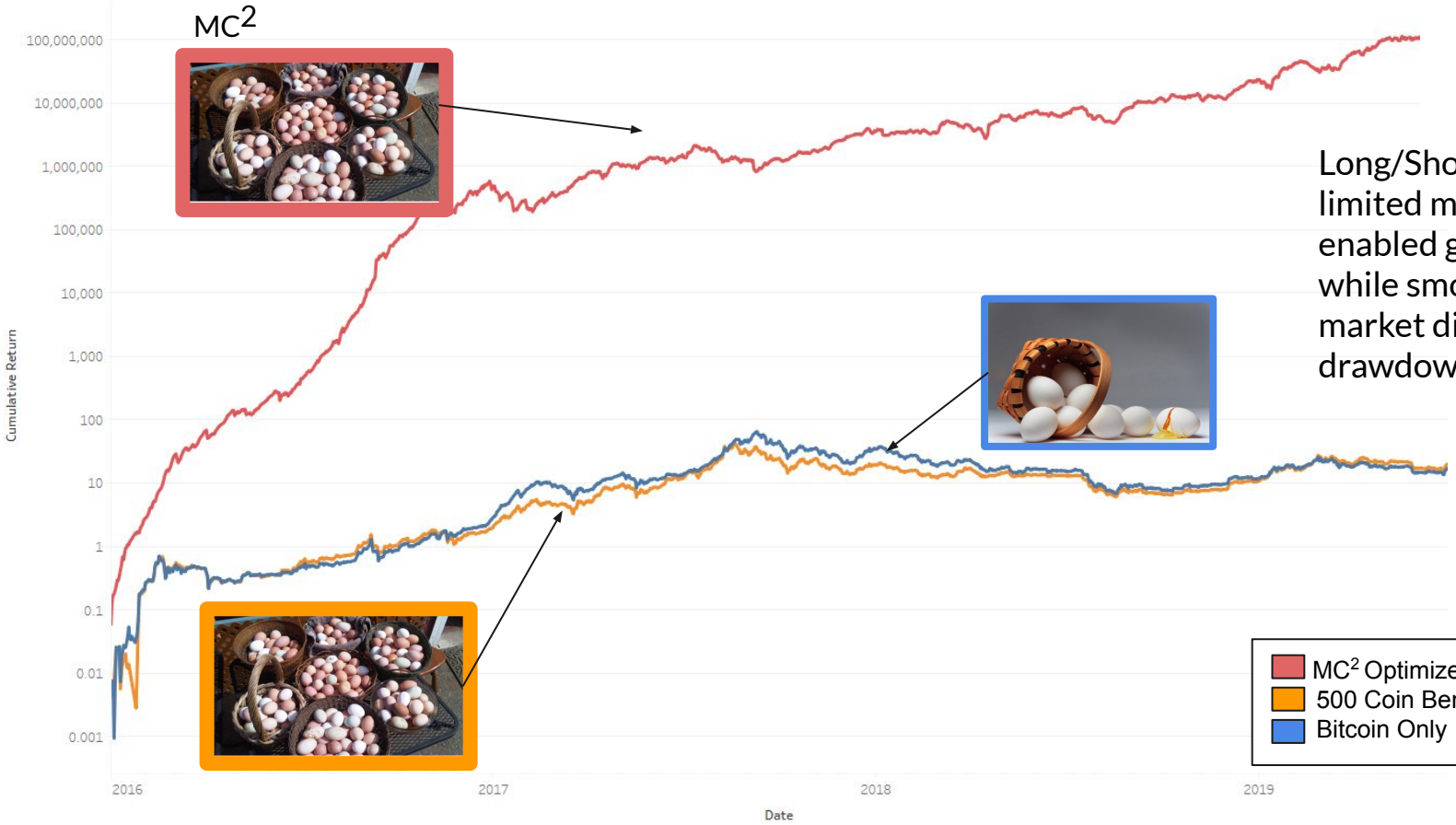
The $200 B cryptocurrency market is a high growth opportunity for investors, but its volatility prevents many institutional investors from taking advantage of this asset.

Mission

Build a cryptocurrency portfolio that is <u>controlled</u> for <u>volatility</u> and provides <u>consistent return</u>

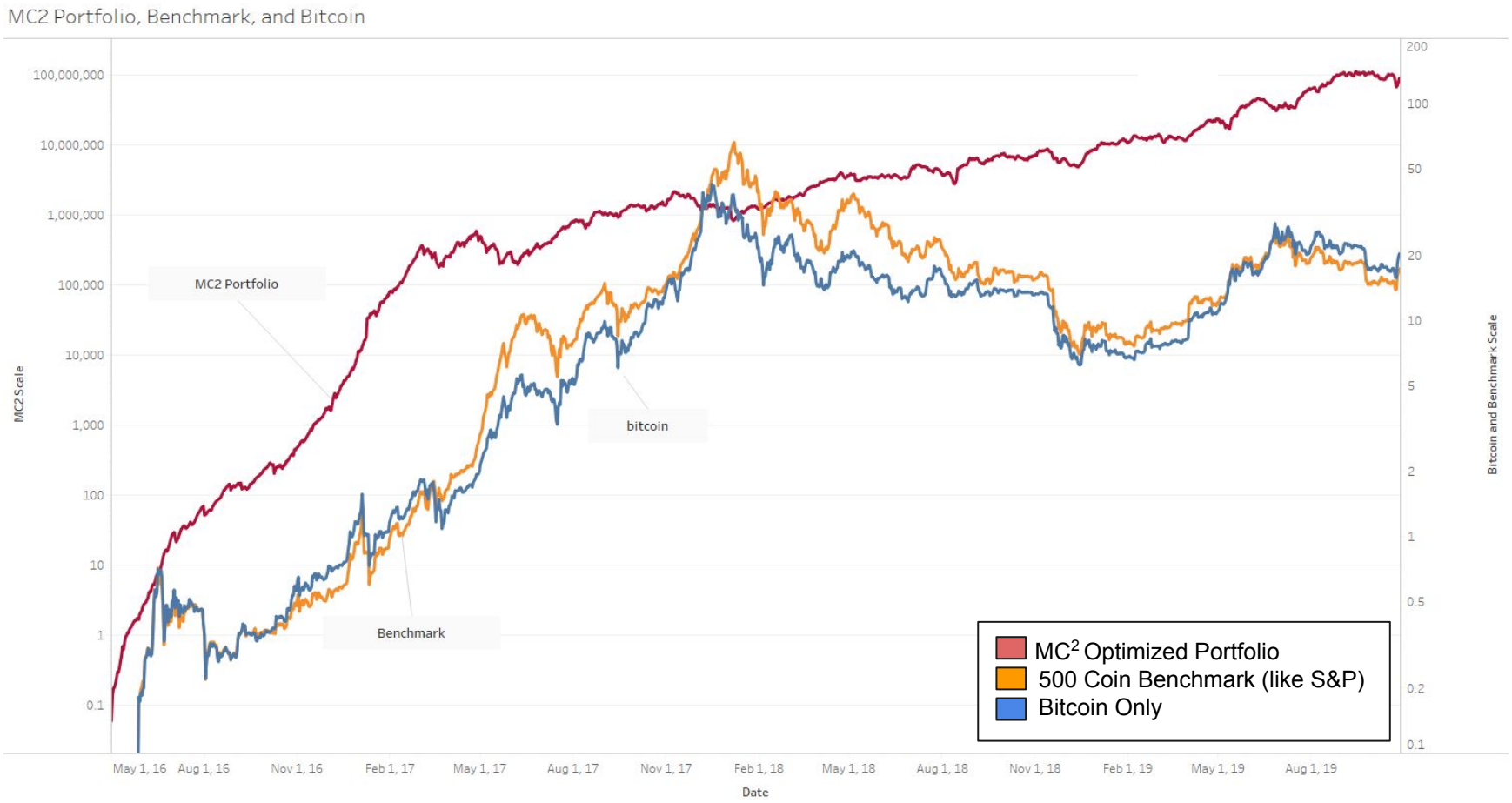
Mission Accomplished - Consistent Return

MC2 Portfolio, Benchmark, and Bitcoin

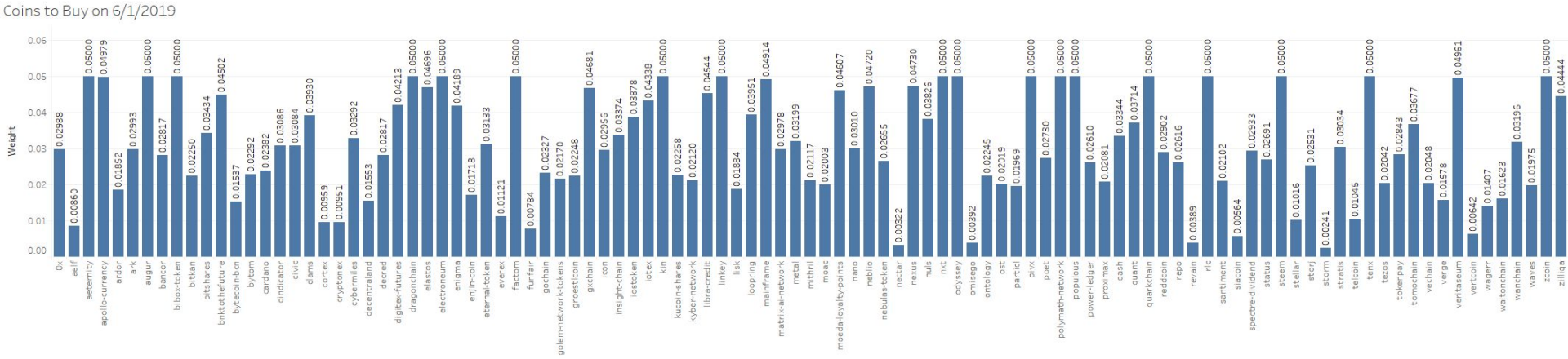


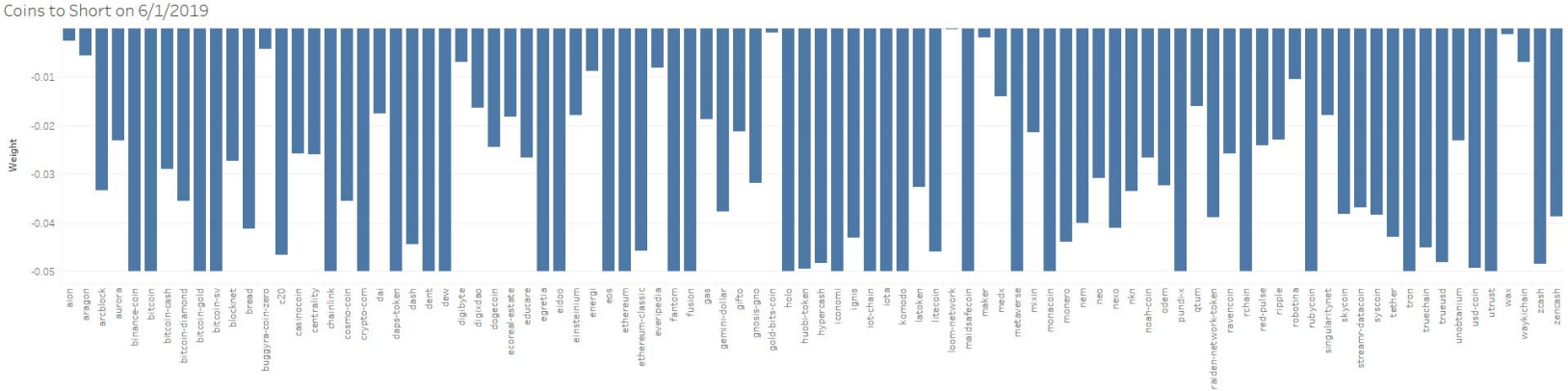
Long/Short Strategy with limited market exposure enabled great returns while smoothing out the market dips (market drawdown)

Mission Accomplished - Reduced Volatility

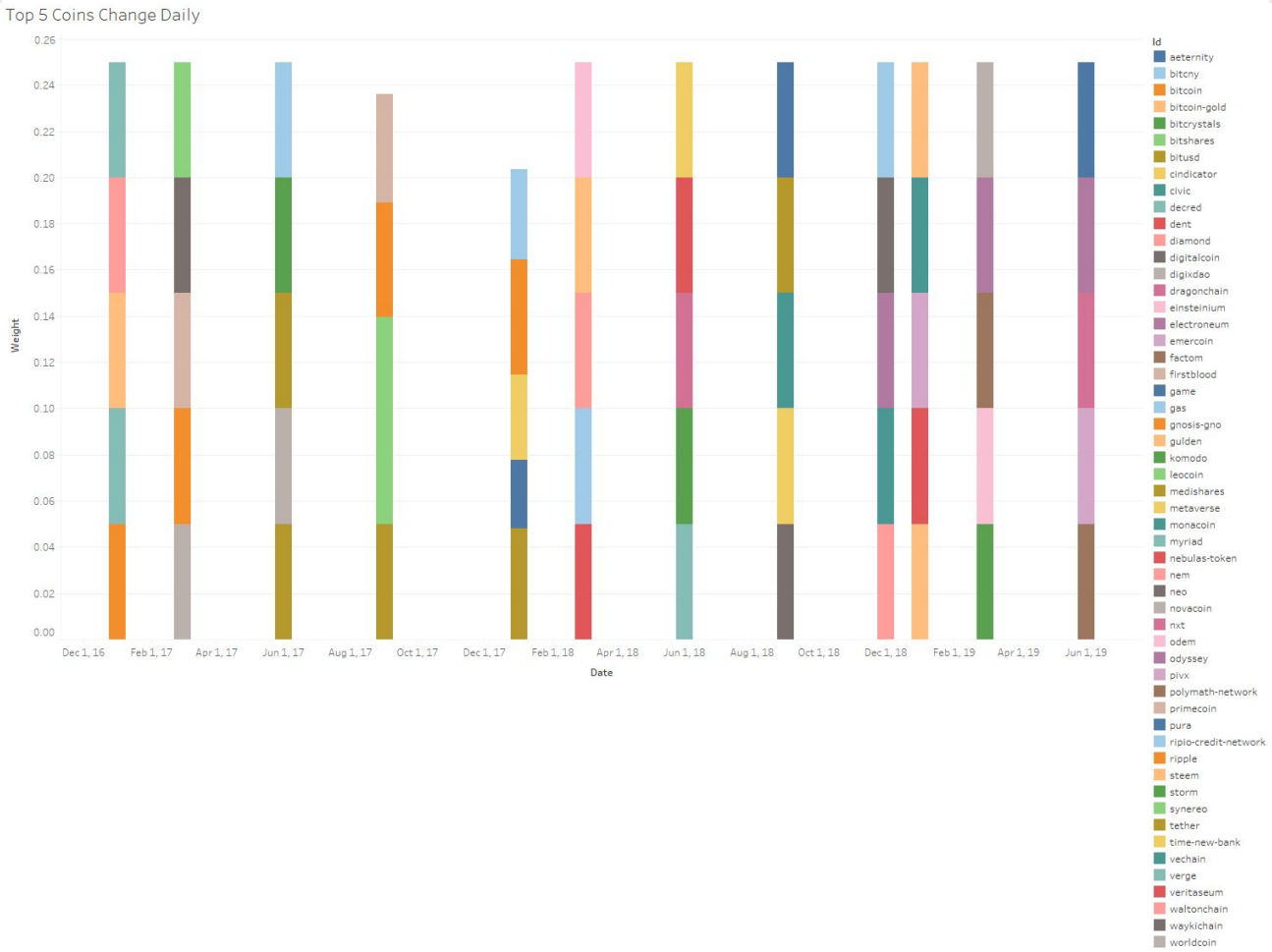


How We Did It - Snapshot of June 1, 2019

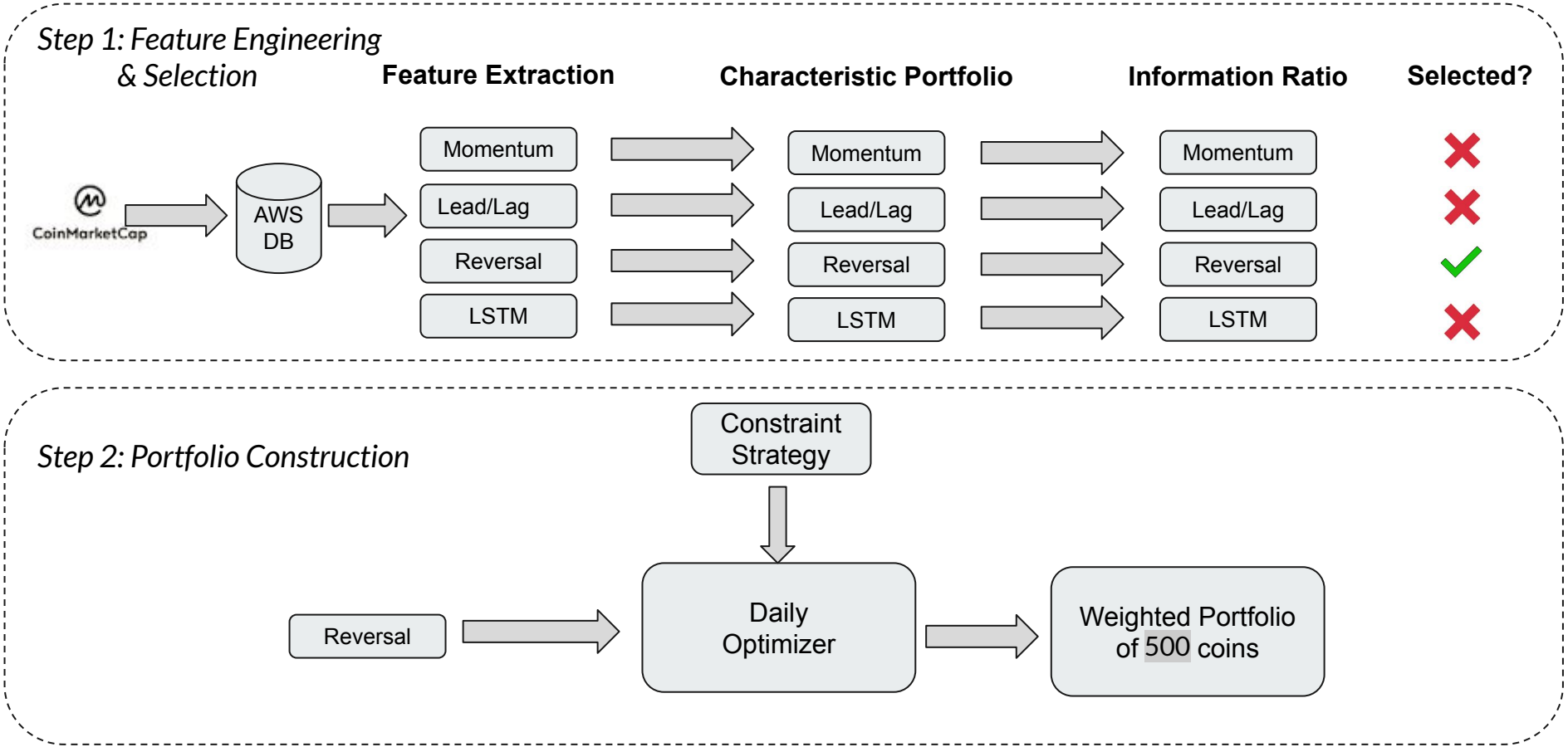




How We Did It

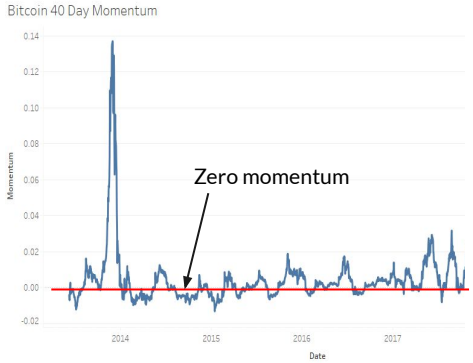

Top 5 Coins Change Daily
Weight
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Dec 1, 16
Feb 1, 17
Apr 1, 17
Jun 1, 17
Aug 1, 17
Oct 1, 17
Dec 1, 17
Feb 1, 18
Apr 1, 18
Jun 1, 18
Aug 1, 18
Oct 1, 18
Dec 1, 18
Feb 1, 19
Apr 1, 19
Jun 1, 19
Date
Id
aeternity
bitcny
bitcoin
bitcoin-gold
bitcrystals
bitshares
bitusd
cindicator
civic
decred
dent
diamond
digitalcoin
digixdao
dragonchain
einsteinium
electroneum
emercoin
factom
firstblood
game
gas
gnosis-gno
gulden
komodo
leocoin
medishares
metaverse
monacoin
myriad
nebulas-token
nem
neo
novacoin
nxt
odem
odyssey
pivx
polymath-network
primecoin
pura
ripio-credit-network
ripple
steem
storm
synereo
tether
time-new-bank
vechain
verge
veritaseum
waltonchain
waykichain
worldcoin

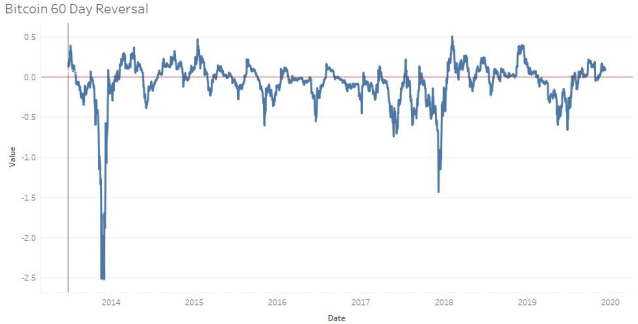
High Level Approach



Feature Engineering

	Momentum	Lead Signal	Reversal Signal	Predicted ROI
Intuition	Measure Trend Strength of Trend Bullish vs Bearish	"Star" currencies move first, other follow (right chart)	Detect a reversal of uptrend or downtrend	Daily predicted ROI from previous 50 days (LSTM)
Computation	$Price_T$ - $Price_{T\text{-}N\_days}$	mean, weighted-avg	$Price_T$ - avg(Prices)	$ROI(c,t_i) = \frac{price(c,t_i) - price(c,t_i-1)}{price(c,t_i-1)}.$
Tunable Parameters	# of day N 10,20,30,40	# days, # top currencies	# days best 60 day	Coin's Features, Epochs, dropout





Feature Selection starts with Characteristic Portfolio

For a **feature a,** we can construct a Characteristic Portfolio that has minimum risk and a unit exposure to **feature a.** The Characteristic Portfolio will help us compute the information ratio (IR) for feature selection

For a feature **a**

$a = \{a_{C1}, a_{C2}, \ldots, a_{C500}\}$

V = Covariance Matrix

$$\begin{array}{c|c} & \begin{array}{cccc} C_1 & C_2 & *** & C_{500} \end{array} \\ \begin{array}{c} C_1 \\ C_2 \\ * \\ * \\ * \\ C_{500} \end{array} & \begin{bmatrix} \sigma^2_1 & \sigma^2_{1,2} & *** & \sigma^2_{1,500} \\ \sigma^2_{21} & \sigma^2_1 & & \sigma^2_{2,500} \\ * & & * & \\ * & & & * \\ * & & & \\ \sigma^2_{500,1} & \sigma^2_{500,2} & & \sigma^2_{500} \end{bmatrix} \end{array}$$

$$w_a = \frac{V^{-1}a}{a^T V^{-1} a}$$

1

Solve for characteristic portfolio weight

$w_a = \{w_{C1}, w_{C2}, \ldots, w_{C500}\}$

2

$$\frac{\text{Average (returns)}}{\text{STDEV (Returns)}}$$

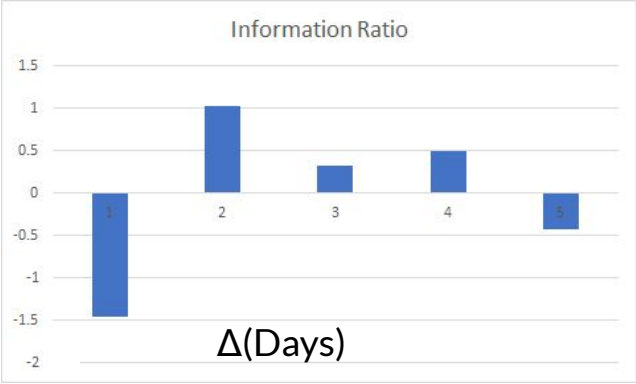
1 Analytical Solution Secret sauce

2 IR (Daily returns computed)

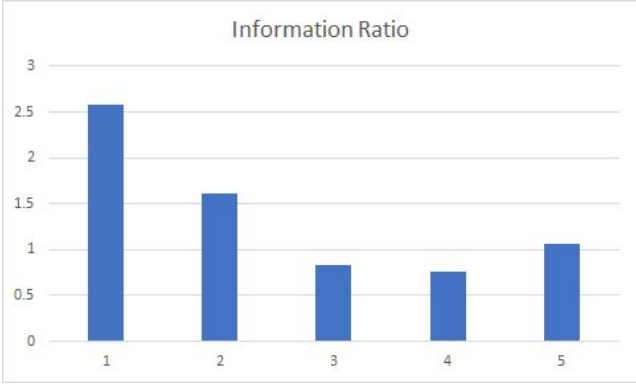
See appendix for detailed formulas

Feature Selection Using Characteristic Portfolio Results

20 Day Momentum ✗



60 Day Reversal ✓



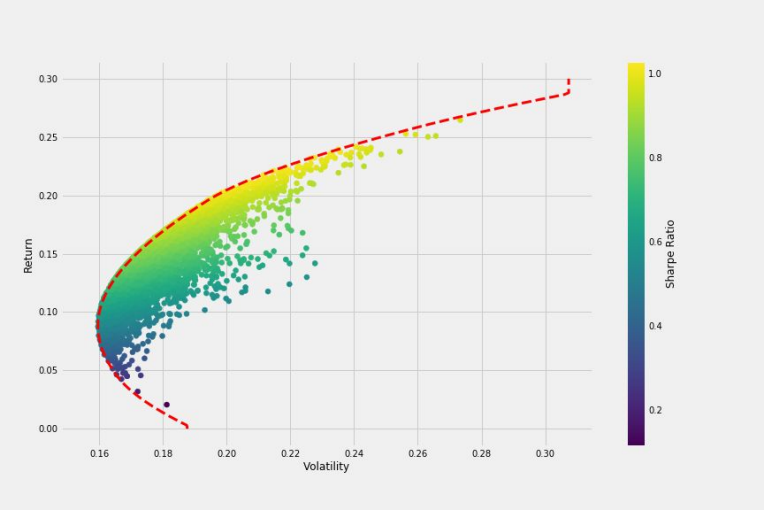
Δ (Days)

$$IR = \frac{\text{Average (returns)}}{\text{STDEV (Returns)}}$$

Portfolio Construction

Modern Portfolio Theory (MPT)

- There is a trade-off between risk and return
- Risk is measured as the standard deviation of return
- Efficient Frontier



Source: https://towardsdatascience.com/python-markowitz-optimization-b5e1623060f5

Capital Asset Pricing Model (CAPM)

$$E(R_i) = R_f + \beta_i(E(R_m) - Rf) + \epsilon_i$$

- Systematic risk and specific risk
- Idiosyncratic risk can be reduced through diversification
- Beta (coefficient) measures the exposure to the market movement

Portfolio Construction

Lagrange Optimization

Utility function (maximize):

alpha - λ * *Var*

λ: how much we want to penalize the risk

Constraints:

Fully invested / money neutral

Tracking market / limit market exposure

Bounds:

Maximum exposure to a single currency

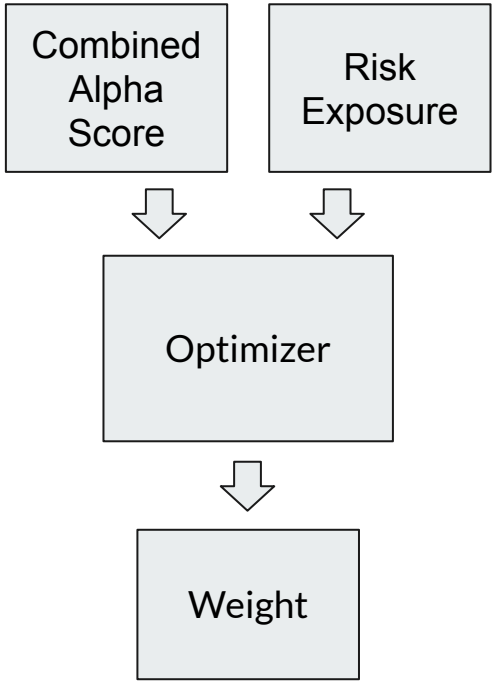
Input:

Aggregated alphas (normalized)

Risk exposure and covariance matrix

Output:

Weights for each asset



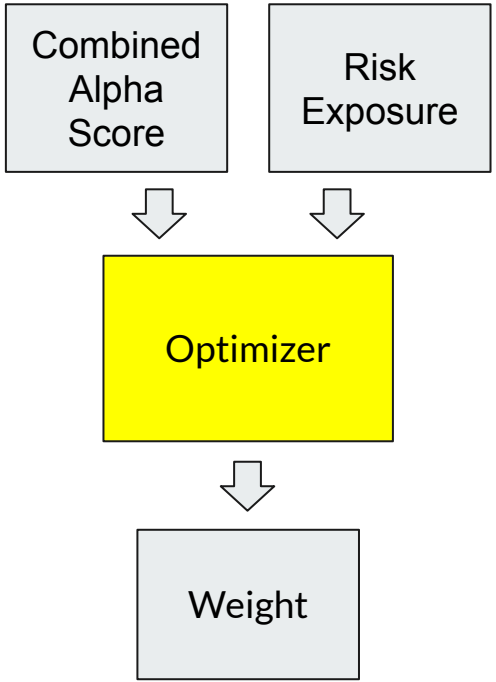
Portfolio Construction

Optimizer

Sequential Least SQuares Programming Algorithm (SLSQP)

- Gradient Based
- NonLinear Constraints
- Widely used among quantitative funds
- Scipy implementation

https://en.wikipedia.org/wiki/Sequential_quadratic_programming



Backtesting

Proposed Strategies

Long-Short

Constraints:

$\text{sum}(w_i) = 0$

$\text{sum}(w_i * beta_i) = b$

Bounds:

$-0.05 <= w <= 0.05$

Params:

$\lambda, b \sim (0, 0.3)$

Long-Only Active

Constraints:

$\text{sum}(w_i) = 1$

$\text{sum}(w_i * beta_i) = b$

Bounds:

$0 <= w <= 0.05$

Params:

$\lambda, b \sim (0.5, 1)$

Parameter tuning

Dev data

2016 - 2018

Test data

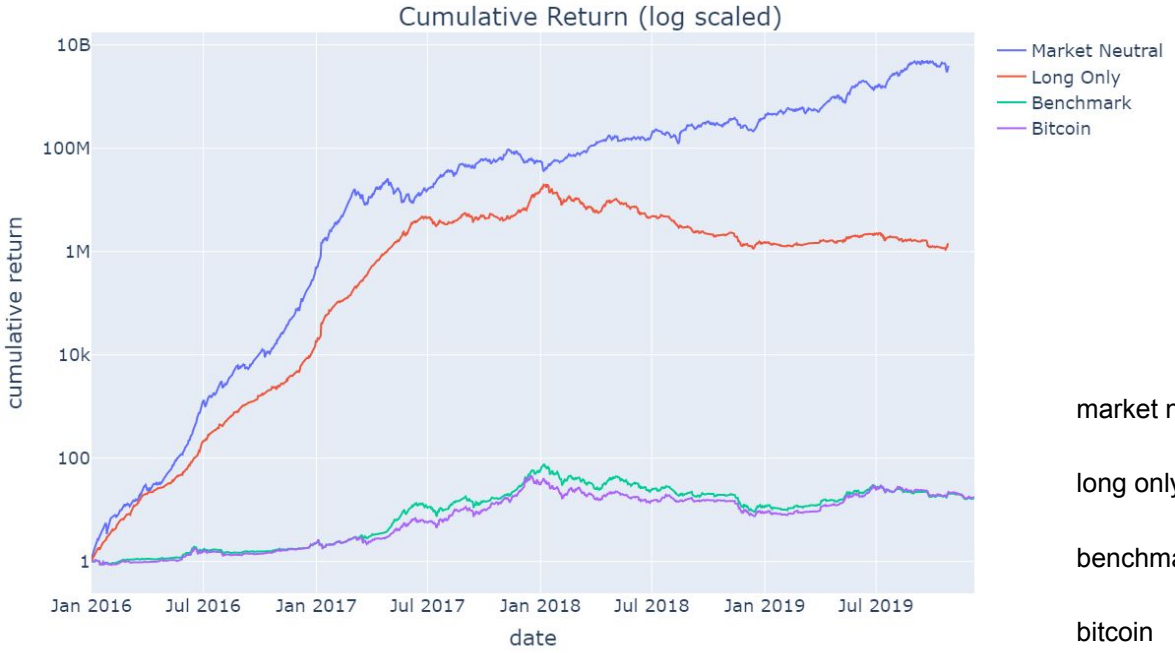
2019

Performance measurement

Return

Sharpe ratio

Results



Sharpe Ratio

	1 year	2 year	3 year	Since 2016
market neutral	3.17	2.59	3.98	5.30
long only	-0.29	-0.27	2.66	4.38
benchmark	1.10	-0.06	1.33	1.33
bitcoin	1.48	-0.16	1.33	1.34

Achievements and Learnings

- Generalized traditional financial market theory to cryptocurrency and layered in machine learning techniques

- Key Learnings
  - Cryptocurrency Market
  - Financial Engineering Techniques
  - Python Optimizer

- Key Challenges
  - Market History is limited
  - Volatile Data

- 100M in revenue gains since May, 2016 and low draw back

Next Steps and Areas for Improvement

- Coin Clustering
  - Stable Coins
  - Market Leaders
  - Interest Bearing Coins
- Back Testing in varied market scenarios
- Explore New Signals
- Tune LSTM signal
- Refine the Risk Model to include more factors
- Refine the Optimizer
- Integrate Transaction Costs

Testimonials From the Field

“Interesting approach, let’s talk when you integrate transaction costs” - Manager at Hedge Fund

“Textbook approach to the art of signal identification. Beautiful” - Financial Engineering Enthusiast

“I am going to use a similar code structure at my job.” Ted and Marcus

Wrap Up

We set out to build a cryptocurrency portfolio that balanced volatility and return by applying a systematic investment approach to crypto currency

We leveraged financial engineering including Min Variance Optimization and Characteristic Portfolio in a machine learning like environment. We also experimented with machine learning algorithms like neural net.

Bottom line, our portfolio's max draw down never dipped significantly despite huge drops in the market over the past 3 years.

Interested? For more information, please check out our website at

http://groups.ischool.berkeley.edu/crypto_portfolio/crypto_portfolio/.

Appendix