Welcome

We will begin promptly at 8:30 PM ET

If you are unable to hear the speakers, just let us know in the chat box.

You can find a copy of the slide deck and a recording of this webinar:

www.fdpinstitute.org/webinars
www.caia.org/caia-infoseries

FDP INSTITUTE®

Financial Data Professional Institute

FDP Institute provides world class training and education to financial professionals to meet the accelerating needs of digital transformation in the industry.

The FDP Institute

The FDP Charter

The FDP Institute offers a self-study program that provides financial data professionals an efficient path to learn the essential aspects of financial data science.

Financial Data Professional Institute℠ was created to

- ✓ Provide financial professionals with the knowledge necessary to succeed in an industry disrupted by the advent of big data and machine learning.
- ✓ Advocate for the highest levels of professional ethics and standards.
- ✓ Establish the FDP Charter as a global professional designation in the area of financial data science.

ONE COMPREHENSIVE EXAM
Offered twice per year.
(Q2 & Q4)

TWO ONLINE CLASSES
Choose either Python or R,
www.fdpinstitute.org/onlineclasses

EARN YOUR FDP DESIGNATION
A globally-recognized charter is awarded to FDP Charter holders.

VALUE ADD
Employers increasingly seek to find professionals who have the skills to apply data science tools to solve their most challenging problems.

Introductions

Keith Black, Ph.D., CAIA, CFA, FDP
Senior Advisor,
FDPI

Alan Waldman
Co-Founder & CEO
Pareto Frontier Capital Holdings

Today's Topic:
Algorithmic Trading and Machine Learning for Crypto Assets

PARETO FRONTIER CAPITAL HOLDINGS

DISCLAIMERS

DISCLAIMERS

General: This slide deck does not constitute an offer to sell or the solicitation of an offer to buy any securities. This slide deck is for informational purposes only and should not be construed as investment advice. Opinions in this slide deck constitute the current judgment of Pareto Frontier Capital Holdings LLC and are subject to change without notice. The summary provided herein does not purport to be complete and does not purport to guarantee similar performance in the future. This slide deck is strictly confidential and any reproduction or other distribution of this material in whole or in part without the prior written consent of the Pareto Frontier Capital Holdings LLC is prohibited.

Investment Risk: An investment in any strategy, including the strategies described herein, involves a high degree of risk. There is no guarantee that the investment objective will be achieved. There is the possibility of loss and all investment involves risk including the loss of principal. The approach and the targeted characteristics of the strategies and investments herein are based on current expectations and should not be considered definitive or a guarantee that the approaches, strategies, and investment portfolio will, in fact, possess these characteristics.

Agenda

1. Challenges facing crypto funds
2. Types of algorithmic trading approaches
3. Reinforcement learning
4. Reinforcement learning in practice: Pareto Frontier's approach and performance
5. Q&A

Challenges Crypto Asset Managers Face: Data

Challenge	Impact
Delayed Market Data	Delays in market data forces managers to make decisions without knowing the current market sentiment.
Limited Historical Data	There is limited access to historical data across crypto markets given their novelty which negates the ability to back test or train models.

Challenges Crypto Asset Managers Face: 24/7 Market Hours

Challenge	Impact
24/7 trading	Given 24/7 trading, asset managers, depending on their infrastructure, often have difficulties adapting to changing market conditions. Also, this requires many firms to have offices throughout many jurisdictions resulting in costly operations.

What Types of Trading Algorithms Exist?

Some algorithms (deterministic and non-deterministic):

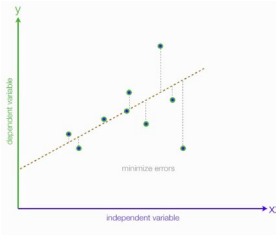
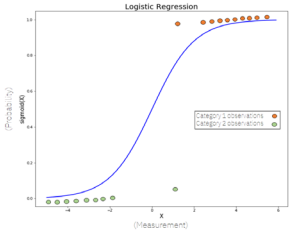
- Technical Analysis / Candle Shape-Based
- Statistical Modeling
- Machine Learning
- Reinforcement Learning

Technical Analysis / Candle Shape-Based

Source: TradingView

Algorithm class	Pros	Cons
Technical Analysis / Candle Shape-Based	• Easy to implement • Many crypto tools and some exchanges provide TA overlays	• Anecdotal results • Confirmation bias • Self-fulfilling • Usually does not work well, especially across different market regimes

Statistical Modeling

Method		
Linear regression		• Used to explain how a much of the variance in the dependent variable is explained by other independent variable(s) • Continuous • OLS
Logistic regression		• Used to predict the probability of an event occurring or not • MLE
Bayesian inference	$P(H \mid E) = \frac{P(E \mid H) \cdot P(H)}{P(E)}$	• Used for updating probabilities given new information ("likelihood" * prior probability / marginal likelihood)

Algorithm class	Pros	Cons
Statistical Modeling	Generalizable	Depends on underlying assumptions about the market, which are often short-lived or wrong

Machine learning (supervised learning)

Supervised learning takes an input and maps it to an output based on previous data it has seen. Some popular machine learning algorithms include Support Vector Machines, Random Forests, K-Nearest Neighbors and Neural Networks.

Algorithm class	Pros	Cons
Machine learning (supervised learning)	Algorithm can decide what is important, often in ways humans cannot	Any human bias is propagated into the algorithm, resulting in sub-par performance

Challenges Crypto Asset Managers Face: Difficulties utilizing machine learning for trading

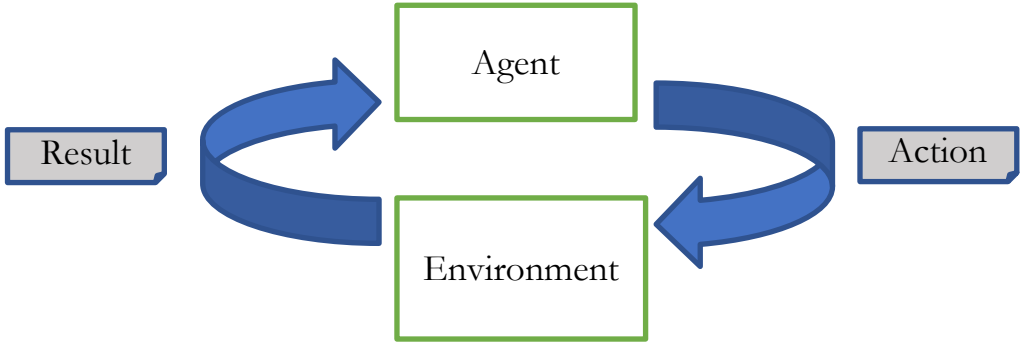
Challenge	Impact
Model development	Advanced and effective machine learning models take extensive amounts of time and computational power to develop.
Difficulties with time-series data	Time-series data presents issues due to non-stationarity.
Changing market regimes	This presents issues when facing market conditions not observed in training.

Reinforcement learning Introduction: games

Reinforcement learning has gained notoriety in recent years due to notable achievements in gaming. AlphaGo Zero and MuZero have started a flourishing field of using reinforcement learning to beat grand-masters at their own game. In chess, Go, Atari, and other games they have shown humans new strategies.

Source: DeepMind, The New Yorker

Reinforcement learning: overview



Applying Reinforcement Learning to cryptoasset markets

At Pareto Frontier Capital Holdings, we develop proprietary and scalable systematic trading technologies utilizing reinforcement learning algorithms currently applied to the cryptoasset markets.

Our Approach

Our algorithms make decisions in real-time and learn from their previous decisions by rewarding good decisions and penalizing poor ones to learn how to trade virtually any crypto asset market and generate positive alpha returns.

Our approach has worked well across various market regimes as the system continually learns how to trade, regardless of whether it saw them in training or not.

Applying Reinforcement Learning to crypto markets

To effectively use reinforcement learning for crypto trading we need three components: a market model, a "trader" model, and a trading objective. The idea is that our "trader" interacts with the market model and tries to maximize the trading objective, all while learning the repercussions of its actions on the market. While reinforcement learning is not new, and many other areas have seen great improvements due to reinforcement learning, trading has remained elusive due to the nature of the problem, as all three parts listed above are very difficult to define.

The market model: In general, the environment model for reinforcement learning defines the "world" in which it lives. For video games, it might be all of the pixels on the screen. For trading, the model is effectively unbounded and therefore cannot be fully defined or observed. Instead, a proxy has to be made for the market which captures all of the essential information.

The "trader": In general, there is an agent which interacts with the environment and is the one who performs actions.

The trading objective: In general, there is an objective function which is maximized by the agent through the process of interacting with the environment.

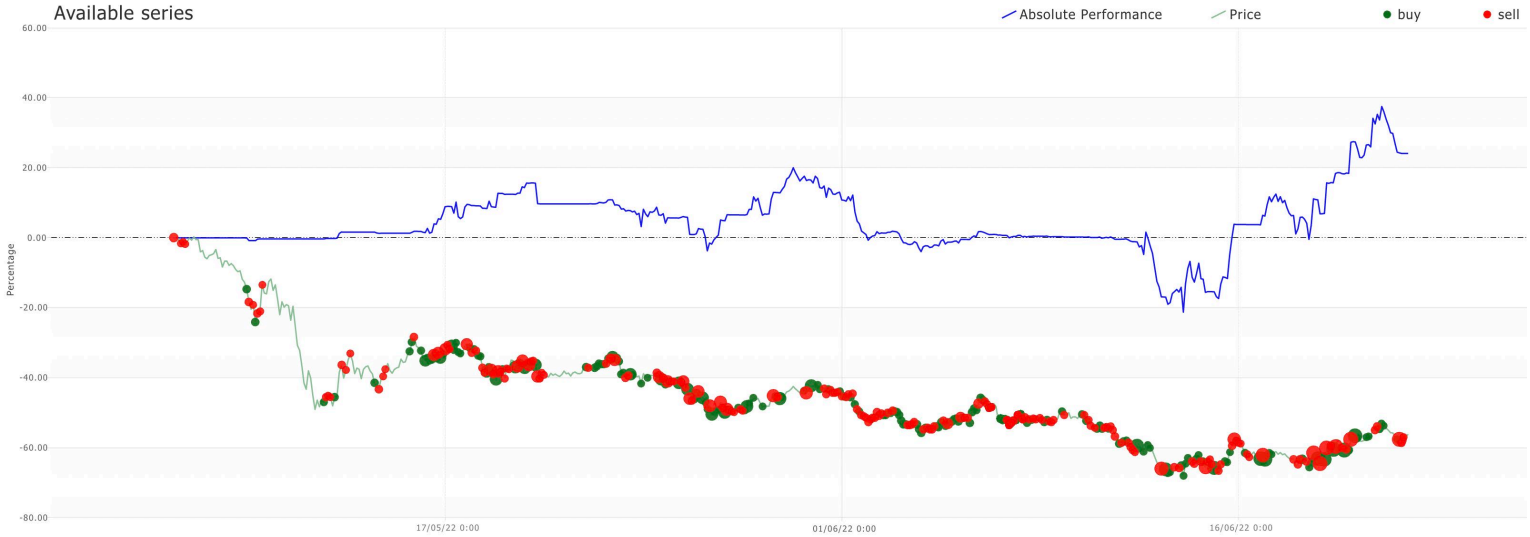
Reinforcement learning for trading

Algorithm class	Pros	Cons
Reinforcement learning	• Does not have bias because it only follows an objective function. • Learns the trading landscape by trading and simulating trades, thus learning real human reactions to actions, as opposed to modeled ones. • Can formulate a multi-trade plan across time. • No inherent limitations on trading strategy complexity.	• All aspects of the problem are ill-defined • Difficult to implement; no plug-and-play model exists. • Requires extensive data sets to truly leverage all the benefits. • Requires powerful computational resources to allow maximal exploration of trading environment.

As mentioned previously, humans have learned new moves in chess and Go from reinforcement learning algorithms. Similarly, we have deepened our understanding of trading by observing the trading models.

RL Approach: Performance - BAT/USD

RL Approach: Performance - SOL/USD



How has reinforcement learning worked for us?

Pareto Frontier Capital Holdings Selected Performance History

Market	Strategies	Net absolute returns, annualized[1]	Sharpe Ratio	Max drawdown	Information Ratio (Pareto Strategy vs. Benchmark)	Correlation (Pareto Strategy to Benchmark)
BATUSD	BATUSD Pareto Strategy	187.07%	2.03	-33.85%	1.80	0.75
	Benchmark: Hold 100% of Base currency (BAT)	25.48%	0.17	-69.21%		
AVAXUSD	AVAXUSD Pareto Strategy	30.23%	0.31	-33.69%	0.54	0.84
	Benchmark: Hold 100% of Base currency (AVAX)	-5.17%	-0.07	-56.71%		
ETHUSDT	ETHUSDT Pareto Strategy	69.48%	0.98	-28.80%	2.06	0.82
	Benchmark: Hold 100% of Base currency (ETH)	-30.86%	-0.40	-54.31%		
SOLUSD	SOLUSD Pareto Strategy	377.91%	5.33	-11.31%	-0.42	0.90
	Benchmark: Hold 100% of Base currency (SOL)	394.91%	4.39	-23.04%		

Note: data as of April 2nd, 2022.

[1] Absolute returns are live paper trading returns, net of estimated fees and slippage. Long only, no leverage.

Thank You

Contact Us:

Pareto Frontier Capital Holdings

alan@paretofrontier.ai

Thank You

Contact Us:

fdpinstitute.org

info@fdpinstitute.org

@FDPInstitute

linkedin.com/company/FDP Institute