Robo-advisory Platform

for Digital Asset Investment

WHITEPAPER

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Abstract

CryptovationX was established by Cryptovation and two major collaborators - AVA Advisory and Asia Wealth Group. It aims to assist crypto investors by utilizing Artificial Intelligence (AI) to build a best of breed robo-advisory platform for digital asset investment. The project will develop iOS and Android mobile applications equipped with six basic features and three robo-advisory functions including Arbi (Arbitrage trading), Specto (Speculative trading), and Broca (ICO and digital asset management service provider investing).

CryptovationX also aims to assist in solving socio-economic problems such as education, unemployment and poverty by implementing a corporate social responsibility program called 'Wealth for All' Initiative, which has two strategies: 1) the Financial Education Mechanism - a program that allows everyone to become an analyst (Predictor) and be compensated for so doing, together with a grant to support other social organizations and 2) the Blockchain x AI Ecosystem - a program that encourages knowledge sharing and nurturing a new innovation to integrate into and improve our platform through annual conference and competitions.

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1. Background and Introduction

1.1 Problems

1.1.1 Cryptocurrency Market Problems

Blockchain technology was first introduced in 2008 by an anonymous coder called 'Satoshi Nakamoto' through the publication of a paper titled 'Bitcoin: A Peer-to-Peer Electronic Cash System'. The paper describes the use of payment from one party to another without an intermediary financial institution through a peer-to-peer network and hash network timestamped transactions into an ongoing chain of hash-based proof-of-work. This paper paved the way for the beginning of the Decentralization and Cryptocurrency era.

However, it can be daunting for new investors (or potential investors) to step into the world of cryptocurrency investment as the high volatility of the market may cause cryptocurrency values to drop sharply in a short period of time, causing amateur traders to panic and attempt to cut losses. Furthermore, this emerging market is inefficient. Asymmetric information leading to extreme price differences in the same digital asset between each exchange portal still occurs. For example, the so-called Kimchi Premium where cryptocurrencies generally sell for higher prices in South Korea, has been in effect since 2017 and demonstrated around 40 per cent premium during early 2018.

To address such problems, a platform that can pool together sets of information in one place for people to access and understand easily is required. Education and training regarding the difficulties and challenges of trading and investing can help an investor to mitigate losses due to fear, uncertainty, and doubt (FUD).

1.1.2 Sustainable Development Problems

Globalization and technological advancements have made the world a better place but problems remain. These are the problems that the United Nations Sustainable Development Goals seek to address. We think we can make a modest contribution to alleviating these problems by way of our corporate social responsibility initiative described later in this Whitepaper.

1.2 CryptovationX Foundation

The CryptovationX Foundation (https://cryptovationx.io/) was started by several organizations with the aim of **utilizing Artificial Intelligence (AI) to build a best of breed robo-advisory platform for digital asset investment with an overarching vision of 'Wealth for All'**.

The organizations listed below are major collaborators in CryptovationX Foundation.

1. **CXA Global LLC** (https://cryptovation.co/), the founding member of the CryptovationX project, is a limited liability company organized in Nevis. It has developed a robo-advisor called the 'Arbot Robo-advisor' (https://arbot.cryptovation.co/), an open-source program that uses Quantitative Analysis to recommend the most profitable low risk trading opportunities in cryptocurrencies. Cryptovation has developed a Digital asset Arbitrage Terminal (Arbot) which has already been purchased by a number of portfolio managers and hedge funds. These tools assist fund managers with arbitrage strategies in digital assets and ICO tokens.

2. **AVA Advisor** (http://ava.fund/) is an investment Robo-Advisor utilizing AI technology combined with a simple customer UX to help investors increase their investment returns. AVA underwent forward testing on the Thai Stock Exchange using its auto-trading AI function. It also founded Omicron Labs (http://lab.ai), a Cognitive Science and AI Research Lab on Financial Intelligence supported by Sirindhorn International Institute of Technology (SIIT) in Thammasat University. AVA will assist in the development of the AI engine for the CryptovationX Robo-advisory platform.

3. **Asia Wealth Group** (http://asiawealthgroup.com/) is a wealth management business listed on the Nex Exchange (https://nexexchange.com/) in the United Kingdom. It seeks to acquire synergistic companies that have the potential to expand across Asia. As collaborators with CryptovationX, they provide professional expertise and advice.

2. Robo-advisory Platform

'CryptovationX Robo-advisory Platform' will be an iOS and Android mobile application that will contain 6 basic features and 2 advanced features, which will be employed in 3 robo-advisors (2 advanced features for each robo-advisor).

Broadly speaking, the robo-advisors function as personal assistants that will aid users in learning more about digital asset investment, enabling them to make decisions based on data and algorithms. Each robo-advisor will have a persona that can be asked questions, provide tutorials and even help run the user's account based on the preferences of the user. They will also provide opportunities for users to earn tokens that can be within the platform to unlock many new features and services provided by the robo-advisors. More specifically, there will be 5 levels of services available for all users based on the level of the user's membership, as described further below.

The 3 robo-advisors each have a nickname for ease of reference as follows: 'Arbi' for arbitrage trading robo-advisor; 'Specto' for speculative trading robo-advisor and 'Broca' for brokerage robo-advisor. Below is a summary table of the features that will be provided based on the level of user access.

2.1 Table of Feature Accessibility

Robo-advisory Features	Level 1	Level 2	Level 3	Level 4	Level 5
1. Assistant Chatbot	✓	✓	✓	✓	✓
2. e-Learning and Quiz	✓	✓	✓	✓	✓
3. Prediction Game	✓	✓	✓	✓	✓
4. Exchange Registration Assistant		✓	✓	✓	✓
5. Portfolio Management Dashboard		✓	✓	✓	✓
6. Human Language Order			✓	✓	✓
7. Opportunity Signaling*				✓	✓
8. Automatic Execution*					✓

*These 2 advanced features will be delivered by 3 robo-advisors (Arbi, Specto, and Broca).

2.2 General Features

General features are features that are shared among all three robo-advisors as follows:

2.2.1 Assistant Chatbot

The function of this chatbot is to answer questions asked by the user through voice or text. Users can ask about platform features and blockchain-related questions. The chatbot will respond with the best answers using machine learning technology which continuously improves its performance.

2.2.2 e-Learning and Quiz

This function is designed to educate and help users gain a better understanding of investing in blockchain through quizzes and mini-games. Gamification of learning will incentivize users to learn and complete more quizzes or mini-games.

2.2.3 Prediction Game

This feature will offer users an opportunity to be an analyst ('Predictor') by participating in a gamified series of predictability questions regarding digital asset prices, market trends, etc., earning CXA tokens as a reward (see 4.1.2 Financial Literacy Reward).

A sample question could be, "What is the anticipated target price of Ethereum in one week?" with the data collected from answers to this question utilized towards further development of our AI engine through deep learning (see 3. Technology).

2.2.4 Exchange Registration Assistant

The platform can provide a one-stop feature for registration including KYC details such as passports held on our database. CryptovationX will only use such private data strictly for verification purposes across supporting cryptocurrency exchanges and with prior approval from investors.

2.2.5 Portfolio Monitor Dashboard

This feature will allow users to monitor all cryptocurrency accounts the user owns in a single place. By presenting statistics in a dashboard style, the user will be able to obtain important information at a glance. For example, the dashboard can illustrate a list of the cryptocurrencies and digital assets the user has and their total digital asset worth in USD.

2.2.6 Human Language Order

The user can input written language to provide complex instructions helping facilitate automation of digital asset trading. For example, suppose the user wants to purchase a digital asset when the value dips below a certain threshold: here, the user can key the instructions into the system. The degree of complexity can vary depending on the expertise of the user. For example, basic users may input something akin to, "Buy Ethereum when the price drops to $300, and sell Ethereum when the price is $350". Advanced users can input more complex instructions such as, "Every day at 5pm, if the price of Ethereum goes below 5% of the value on the previous day, purchase Ethereum at a rate of no more than 100 per week. If Ethereum is rising by 5%, sell Ethereum but no more than 5 a day."

This feature will be offered in collaboration with an innovation of Capitalise Crypto (https://capitalisecrypto.ai) which uses Natural Language Processing (NLP) Technology, employing human language to translate into commands or actions for a computational system.

2.3 'Arbi' (Arbitrage Trading Robo-advisor)

Arbi is CryptovationX's Arbitrage Trading Robo-advisor. Arbitrage is adjustable-risk trading by simultaneously buying and selling fiat and cryptocurrencies in order to take advantage of price differences of the same asset in different markets.

This process utilizes a large volume of data and multi-step calculations in order to determine if an identified transaction is profitable. Arbi's algorithm will collect information from multiple sources, generate a list of potential opportunities for the user and provide for execution of the arbitraging strategies.

Higher-level user accounts may skip the step of manual execution and directly ask Arbi to complete the multiple steps, including clicking buttons, thereby shortening the process of manual instruction.

Users will be able to receive notifications for any trading opportunities in which they can take a more sophisticated decision as regards trading and investing in cryptocurrency. At this level 'Arbi' also allows the user access to the arbitrage system.

2.4 'Specto' (Speculative Trading Robo-advisor)

Specto is CryptovationX's Speculative Trading Robo-advisor. Speculative trading is the act of trading a financial instrument involving high risk with the expectation of significant returns in order to maximize profit from fluctuations in the market. AVA advisory (www.ava.fund/), with 4 years of R&D and experience in the equity market, will be providing their expertise to develop Specto.

For new investors, Specto will develop predictability tools and pattern/trend analysis for users to gain a better understanding of conventional proprietary trading. For experienced traders, Specto, through use of real-time analysis and AI prediction, aims to provide tools that can help minimize risk, eliminate manual prediction, and streamline execution of speculative trading strategies.

Specto users will be able to receive notifications of real-time trading opportunities supported by a suite of risk management and predictive trade tools Specto can also suggest improvements to the user's trade strategies and provide supporting information designed returns.

2.5 'Broca' (Brokerage Robo-advisor)

Broca is CryptovationX's Brokerage Robo-advisor. Combining detailed industry and sector analysis with thorough assessment of professional, reputable third-party service providers, Broca will recommend ICO investment opportunities and good performance digital asset management service provider.

Participating in ICO fundraising campaigns can be a challenge with reliability and trust key concerns in the minds of investors. Broca can critically analyze ICOs and list them in order of perceived reliability using available data including trend prediction, independent reviews and historical records.

Broca will assist user by signaling ICO listing updates and analyzing potential ICO projects according to whitepaper, existing team, ICO analysis, community feedback, and technical review. Information from various reviewing sites such as Crypto Compare (https://www.cryptocompare.com/), ICO Rating (https://icorating.com/), etc., as well as the general social sentiment by other people involving specific ICOs will be collected for the user's ease of reference.

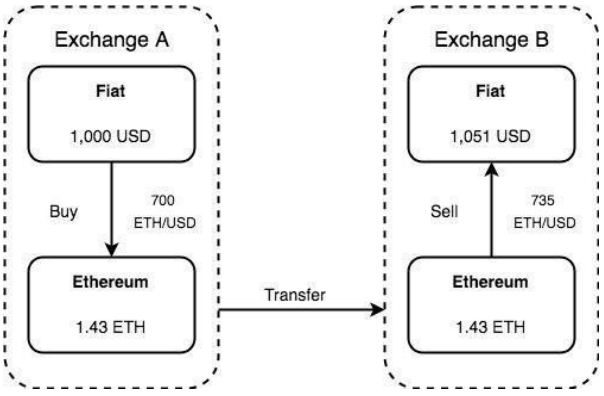
Moreover, although there are many digital asset management service providers in the market, most are not trustworthy and the problem of fraud persists. Broca will gather information, conduct due diligence, evaluate options and serve as a portal for users to access digital asset management services. The user will be able to compare each service provider's past performance and easily start using the service through our platform.

3. Technology

3.1 Digital Asset Arbitrage Model

3.1.1 Single-asset One-way

This is one of the most familiar arbitrage strategies and refers to the purchase of one particular cryptocurrency (Bitcoin, Ethereum, Litecoin, etc.) in a market with a lower market value and reselling it in another market with a higher value. This provides the opportunity to take advantage of differing prices to generate a profit by buying low and selling high. This concept is the simplest and most straightforward means of arbitrage trading. Under this methodology, the fiat currency (most commonly USD) would be held in the destination exchange until the price between two exchanges is stabilized in order to transfer the asset, or to withdraw it and pay the bank transfer fees and exchange rate (in some cases) to complete the loop. Furthermore, 'one-way' can be performed two or three times subject to price volatility and trade direction, with the funds returning back to the starting exchange.

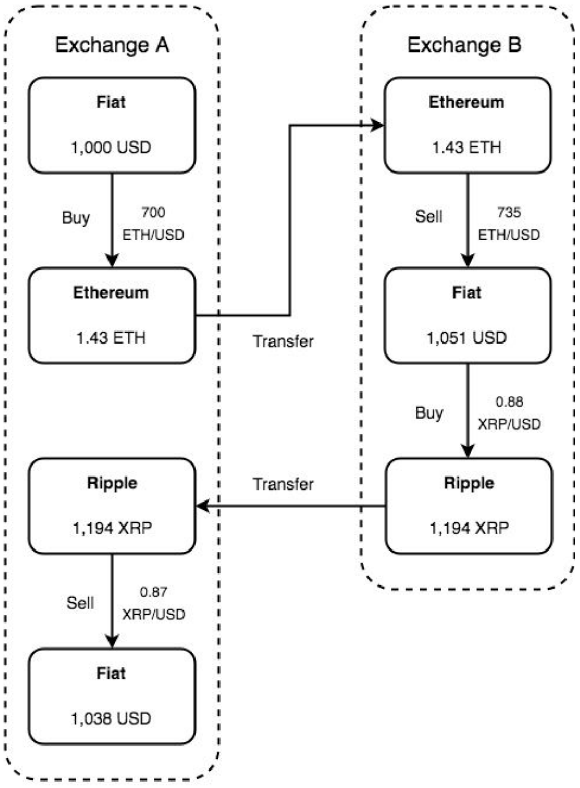


For example, assume the fee is 0%; in exchange A and the Ethereum price is $700. On the other hand, the price of Ethereum in exchange B is $735, so if the trader bought Ethereum in exchange A and transferred and sold in exchange B, then the trader would make a $51 profit.

3.1.2 Two-asset Loop

Two-asset Loop arbitrage refers to two instances of Single-asset One-way arbitrage in order to avoid paying a significant amount of bank transfer fees just to retrieve fiat currencies (and hence losing profit) and shorten the amount of time to complete the loop. The first one-way can have profitable while the second one-way can be marginal or no difference in value. This

allows the user to reap the profit from the first instance while having little to no difference in the second instance through a different cryptocurrency back to the original exchange. The ideal scenario would be where both legs of the trade generate a profit instead of only one. Generally, one of the arbitraging tokens is Ripple or Stellar since their transferring process is one of the fastest.

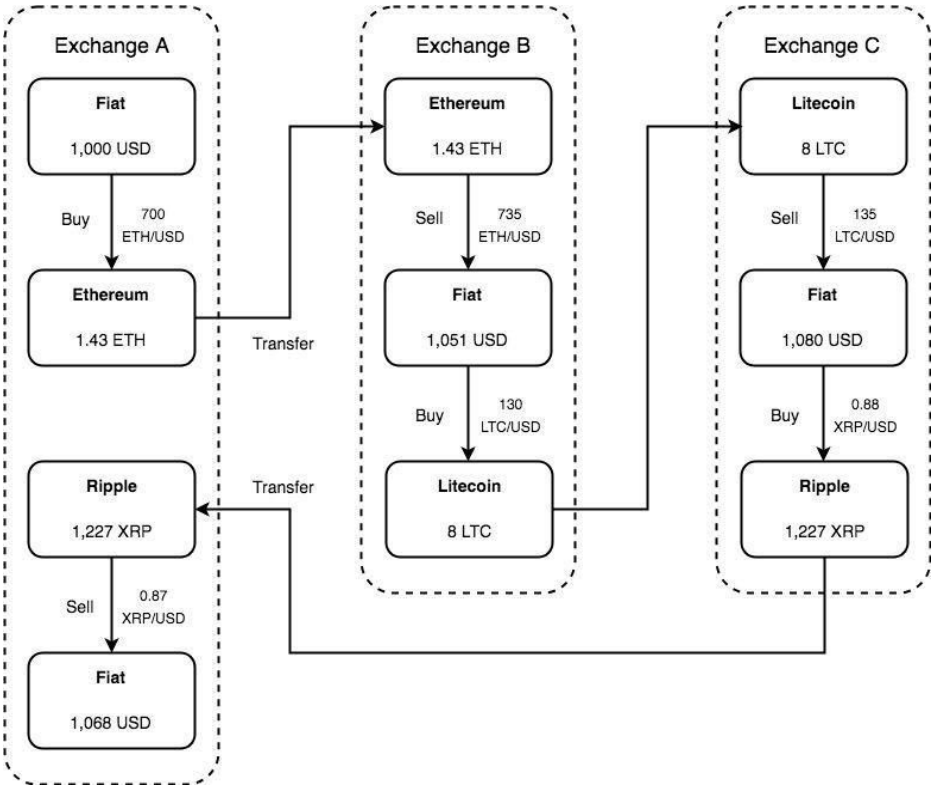


For example, assuming the fee is 0% in figure shown above. The price of Ethereum in exchange A is $700 and the price of Ripple is $0.87. In exchange B the price is $735 for Ethereum and $0.88 for Ripple. In this example, the trader can buy Ethereum in exchange A, transfer and sell it to exchange B then buy Ripple, transfer and sell it back into exchange A. The profit can be reinvested again and will equal to (1,038 - 1,000) = $38.

3.1.3 Cross-exchange Triangle

Similar to the Two-asset Loop arbitrage, the Cross-exchange Triangle loop takes into account three exchanges instead of two, while also taking into account any transactional and platform fees. The pricing discrepancy between the three exchanges will be calculated before conducting the loop. However, as certain cryptocurrencies take longer to transact, there is the risk of sudden price changes over time that may normalize the differences. As a result, the three-way arbitrage may not be fully completed. However, it

is possible to then shift back to a two-way loop until another opportunity arises. Arbitrage strategies are dynamic and interchangeable, which can help to minimize the losses caused by the normalization or dramatic fluctuations.



For example, assume the fee is 0% in the transaction shown above. The price in exchange A for Ethereum is $700 and Ripple is $0.87. For exchange B, Ethereum is priced at $735 and Litecoin is at $130, and in exchange C Litecoin = $135 and Ripple = $0.88. In this case, the trader can buy Ethereum in exchange A, transfer and sell it to exchange B then buy Litecoin, transfer and sell it to exchange C, and buy Ripple in order to transfer and sell it back into exchange A to complete the loop. In this case, the profit can be reinvested again which will equal as follows: ($1,051 - $1,000) + ($1,080 - $1,051) + ($1,080 - $1,068) = $68 .

3.1.4 Internal-exchange Triangle

Another looping strategy is based on the triangle strategy but is executed within an exchange. There is one condition: in order to exploit this strategy, it is necessary for that particular exchange to have three quotations that can be traded in circle (for example; ETH/BTC, ETH/USD, and BTC/USD). Most of the time, these three quoting prices are not equally distributed so

there may be an arbitrage opportunity by making these three trading positions at the same time.

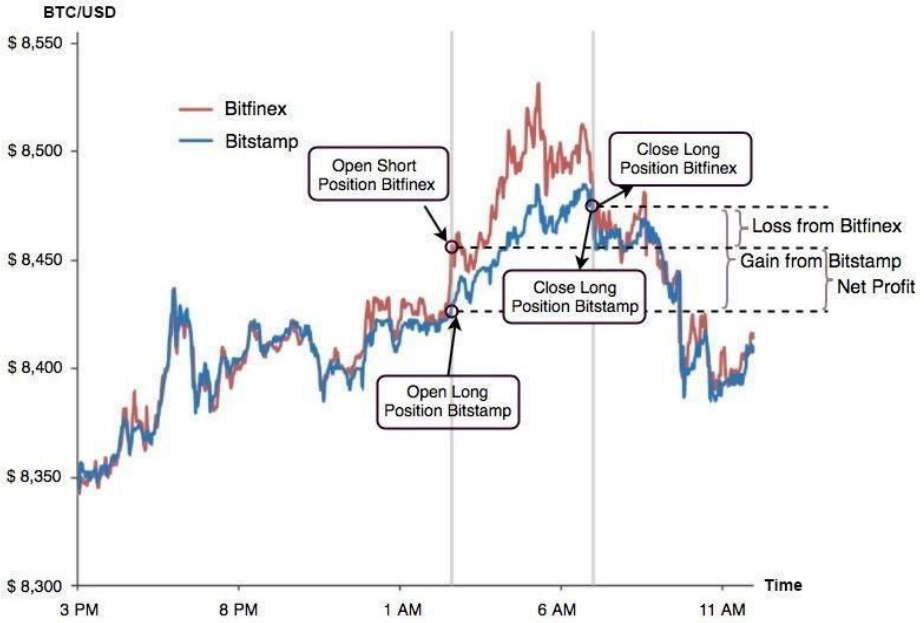
Exchange A

Initial	Rate 1	Rate 2	Final
Fiat 1,000 USD	1,000 ETH/USD	1,000 ETH/USD	**Ethereum** 1 ETH
Ethereum 1 ETH	0.08 ETH/BTC	0.08 ETH/BTC	**Bitcoin** 0.08 BTC
Bitcoin 0.08 BTC	12,500 BTC/USD	13,000 BTC/USD	**Fiat** 1,040 USD (4% Profit)

For example, assuming the fee is 0% in the figure above then Ethereum will swap into Bitcoin, Bitcoin will swap into US dollar, and US dollar will swap into Ethereum. As the position change into one another, a profit of $40 has been made.

3.1.5 Single-asset Long-short

This arbitrage strategy was developed by Julien Hamilton (https://github.com/butor/blackbird). It employs a tool called Single-asset Long-short that can calculate differences between two markets for a certain cryptocurrency and initiates either a long position or a short position. The decision to go short or long is dependent on the market price and the equilibrium midpoint.

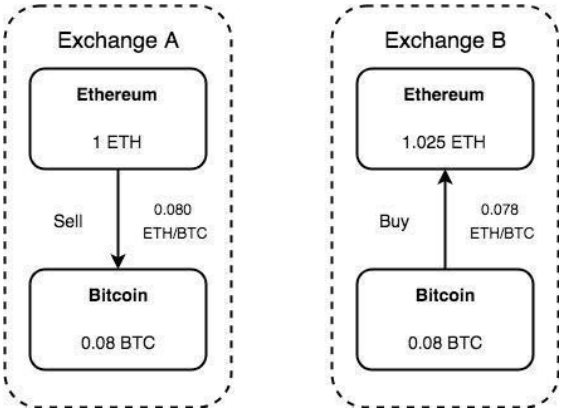


For example, assume the fee is 0% in figure shown above. In Market Bitfinex, the price of Bitcoin is $8,450, but in Market Bitstamp the price of Bitcoin is $8,425. It is likely that when the information about Bitcoin is fully conveyed, it will equilibrate to a midpoint value, for example $8,470. By ordering long for Market Bitstamp and short of Market Bitfinex, the trader will be able to achieve a profit from the differences during equilibrium; in this example ($8,450 - $8,470) + ($8,470 - $8,425) = $25. Prior to the equilibration, the Single-asset Long-short tool will predict the price either going high or going low and set the order accordingly. Any point of change in the value would generate a profit on both exchanges.

3.1.6 Two-asset Buy-sell Swap

This arbitrage technique is developed from the simple loop strategy. Instead of exposing the risk of change in price during the transfer period for the cryptocurrency.

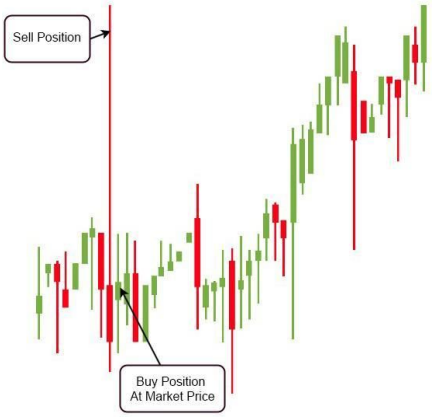
The Two-asset Buy-sell Swap strategy holds positions at both exchanges in cryptocurrency or fiat currency. Whenever the opportunity comes, the trader will switch the position from one currency to another that has the better arbitrage opportunity.



For example, assume the fee is 0% in the figure shown above. There is a difference in the ETH/BTC price as between Exchange A and Exchange B. By switching the position from BTC to ETH in exchange A and vice versa on exchange B, a profit has been made from the difference in the price without the need for transferring any cryptocurrency. Furthermore, if the price of cryptocurrency reverses for both exchanges, then the position can be switched to make profit again or the trader can switch positions by transferring the position from exchange A to B and vice versa.

3.1.7 Single-asset Spike Capture

Sometimes a whale trader wants to change his positions instantly. They place big positions onto the market to take all of the available orders that are deployed in the market. This will spike the price for a few seconds or minutes, until other traders place orders which make things go back to normal.



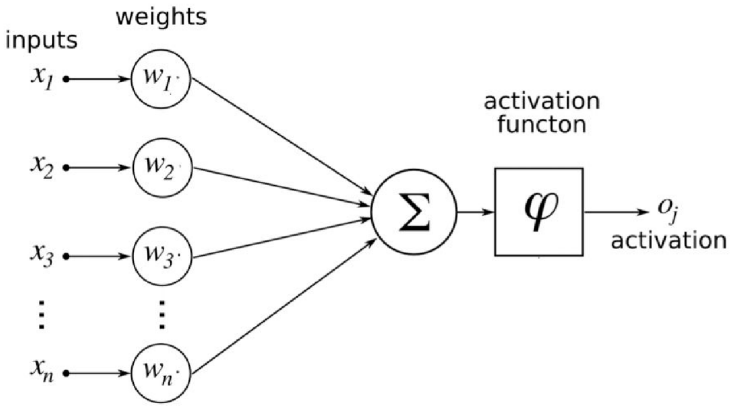
The figure above provides an example of a market in which a Single-asset Spike Capture can be implemented, as demonstrated by a large set of buy orders causing the upward price spike. After the initial positions are made, those positions are squared at the subsequent market rate as shown on the right side of the figure.

3.2 AI Model for Collective Intelligence

Collective Intelligence is shared or group intelligence that emerges from the collaboration, collective efforts, and competition of many individuals and appears in consensus decision making. The term appears in sociobiology and political science, as well as in the context of mass peer review and crowdsourcing applications. It may involve consensus, social capital and formalisms such as voting systems, social media and other means of quantifying mass activity. Collective IQ is a measure of collective intelligence, although it is often used interchangeably with the term collective intelligence.

In this case, those individuals are the 'Predictor' who participate in the 'Prediction Game' (see 2.2.3 Prediction Game) and provide their opinion or theory into the system. With the integrating of both machine and human intelligence into the systematic process, the system will utilize knowledge and data collected from our Predictors to feed into a deep learning system to help improve our AI engine. The following are the deep learning models we will use for this program.

3.2.1 Single Units of a Dense Layer



A unit (or node) in a neural network takes as its input the features x_1, x_2, ... , x_n, and multiplies them by the learnable weights of the unit w_1, w_2, ... , w_n. The output of the unit can be computed by

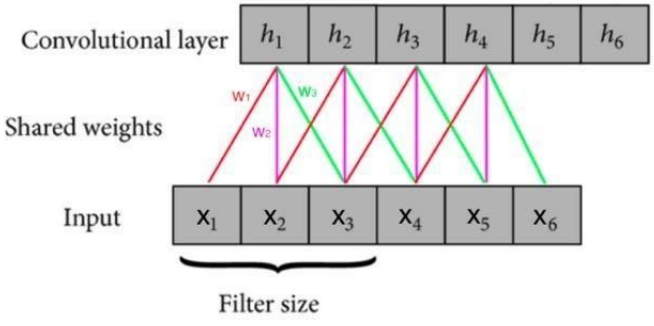
$$o_j = \varphi(\sum_{i=1}^{n} w_i x_i)$$

where $\varphi(x)$ is the activation function. In general, the sigmoid function

$$\varphi(x) = \frac{1}{1+e^{-x}}$$

is used as the activation function.

3.2.2 Convolutional Layers



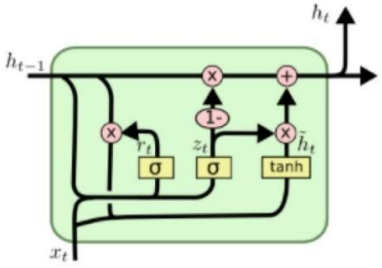
While the units of a dense layer take in all features as input, the units of a convolutional layer h_1, h_2, ... , h_n (e.g., n = 6, as in the figure) take in only partial input features x_1, x_2, ... , x_m (m = 3 in the figure). By doing so, the convolutional layer substantially reduces the number of learnable weights w_1, w_2 , ... , w_n of the network.

In addition to requiring a smaller number of weights, convolutional layers also force each unit to concentrate on processing local input, which helps extract locally useful features. For the convolution layer, we choose a parametric rectified linear unit as the activation function, whose equation is given by

$$\varphi(x) = \begin{cases} x, & x \geq 0 \\ \alpha x, & x < 0 \end{cases}$$

where α is a learnable weight.

3.2.3 LSTM/GRU Layers



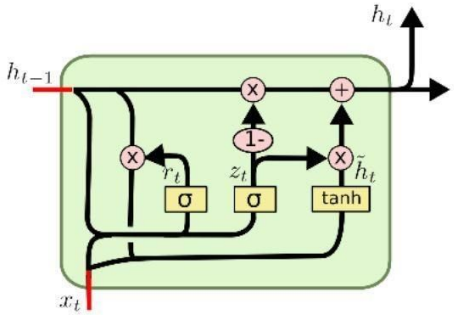
$$z_t = \sigma\left(W_z \cdot [h_{t-1}, x_t]\right)$$
$$r_t = \sigma\left(W_r \cdot [h_{t-1}, x_t]\right)$$
$$\tilde{h}_t = \tanh\left(W \cdot [r_t * h_{t-1}, x_t]\right)$$
$$h_t = (1 - z_t) * h_{t-1} + z_t * \tilde{h}_t$$

Long short-term memory (LSTM) and gated recurrent units (GRU) are recurrent units. The architectures of LSTM and GRU are designed to capture both long-term and short-term dependency. We will use GRU as an illustrative example (shown above) because our model primarily uses GRU and its architecture is similar to that of LSTM.

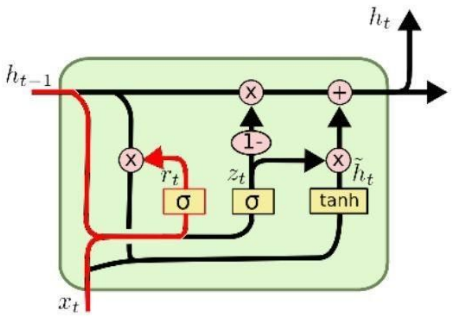
A unit of GRUs takes both the features (from the current time step, x_t) and the output of the node (from previous time step, h_{t-1}) as its input. The input is then independently used to compute two control gates of the unit. Briefly:

- The reset gate (r_t) controls how much the output of the node in the current time step (h_t) depends on the output of the node from the previous time step (h_{t-1}).
- The update gate (z_t) controls how much information the output of the node from the previous time step (h_{t-1}) carries over to the next time step (h_t).

The mechanism of the two gates is described below:

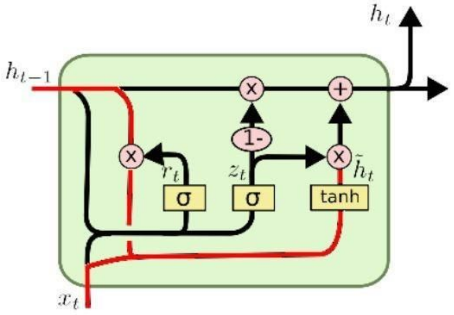


Recall that x_t represents the input to the recurrent unit at time t and h_{t-1} represents the hidden state which was transferred from the previous time t − 1.



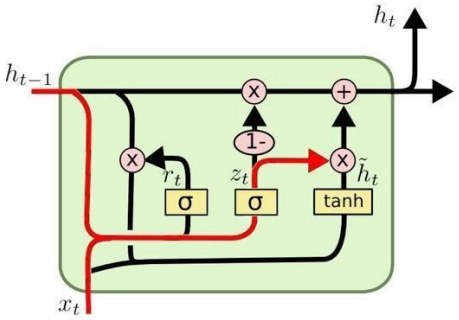
Both x_t and h_{t-1} are combined to compute the reset gate value r_t. The value of r_t ranges from 0.0 to 1.0, where the value of 1.0 means the gate is open for the information from previous time steps to flow to the unit.

Note that the control mechanism is accomplished by multiplying the value of the reset gate r_t by the information flow h_{t-1}.



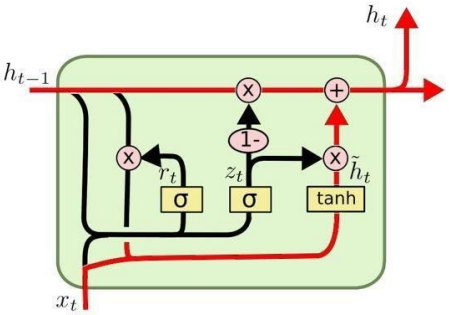
Once the reset gate determines how much information flows through from h_{t-1}, GRU can calculate the output of the node in the same way as a standard neural node.

In the figure, h_t represents the intermediate output of the node in the current time step, where tanh is the activation. Note that in this step, the information of h_{t-1} has been controlled by the reset gate.



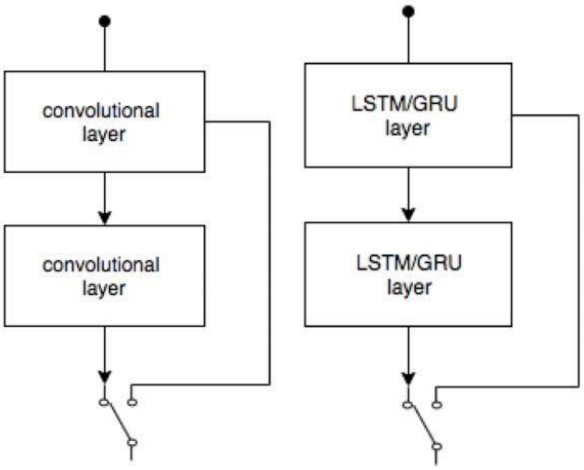
While this process is happening, the update gate is simultaneously computed. The update gate z_t is calculated from both x_t and h_{t-1} in the same way as the reset gate. The value of the update gate z_t ranges from 0.0 to 1.0, where the value of 1.0 means the gate is open for the intermediate output h_t to be the real output of this node.

Likewise, the control mechanism is accomplished by multiplying the value of the update gate zt with the intermediate output h_t.



The rest of the process is to ensure that when the update gate allows the intermediate output h_t to flow out, nothing blocks this flow. Otherwise, when the update gate blocks the intermediate output h_t, it instead passes the information from h_{t-1} as the output.

3.2.4 Residual Convolutional Block and Residual LSTM/GRU Block



A parametric residual block is a technique used to stack convolution layers or LSTM/GRU layers by allowing the outputs of the previous layer (denoted by $o^{(l)}$) to be mixed with outputs of the current layer (denoted by $o^{(l+1)}$).

$$o^{(l)} = \varphi\left(\sum_{i=1}^{n} w_i x_i\right)$$

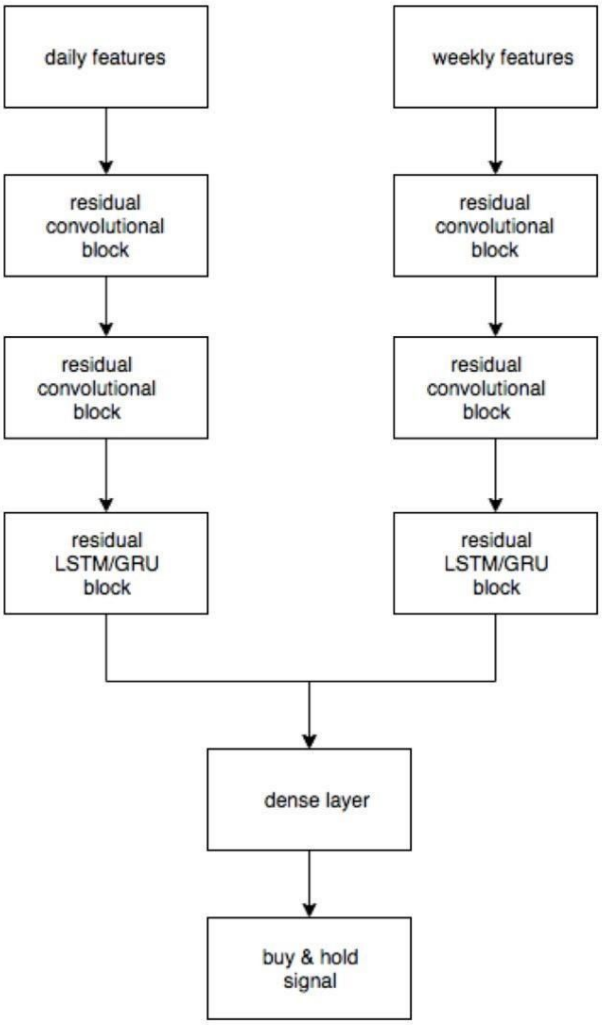
$$o^{(l+1)} = \varphi\left(\sum_{i=1}^{n} w_i o_i^{(l)}\right)$$

$$\hat{o} = \gamma \cdot o^{(l)} + (1-\gamma) o^{(l+1)}$$

where γ is another learnable weight. We can train γ so that the network can automatically choose to pass on an appropriate amount of information from the previous layer to the next.

3.2.5 Ensemble Model

The architecture of our deep learning model can be seen as a two-column ensemble where each column processes the input features from different time-frames, namely, daily, and weekly input features.



As shown above, each column is a stack of two convolutional blocks and one LSTM/GRU block. The output from each column is then concatenated and used to make final predictions by means of a dense layer. Each column can be pre-trained separately and used in an ensemble method before training the last layer. We have found that training the entire model using a multitask method yields a more stable result.

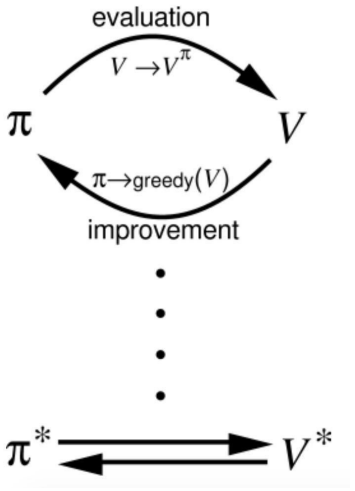
3.3 Deep Reinforcement Learning

The main strategy of our cryptocurrency trading bot is Deep Reinforcement Learning, the basis of AI. It is an experimental strategy for robots to trade in cryptocurrency markets based on patterns in collected data, in order for the robots to experiment, collect results, and design policies that will ensure profitable trading strategies.

For a programmable cryptocurrency robot to make profitable trading decisions across different market environments, using only market price data for the

cryptocurrency during a specific period of time, the robot needs to implement and develop the proper policies to determine what action to take.

The term 'what action to take' presents a chicken-and-egg problem to students of reinforcement learning. That is, a policy is considered 'good' if it results in actions that generate outcomes which are considered 'good', which themselves depend on the policy that was selected, which is the problem that reinforcement learning has tried to solve.



3.3.1 State-space Engineering

State-space engineering involves the use of deep neural networks, such as convolutional neural networks, to collect patterns of primary features and adding high-level features to use as the state space of our model. This achieves a high quality of non-linear features that are other beyond human capability.

The human engineering alternative involves collecting raw data from cryptocurrency markets to process the extraction of features, which necessitates the use of expert human knowledge, which can neither match the speed of automated processes nor be reliably integrated into computer programs. By contrast, state-space engineering can make use of chronological engineering processes to obtain feature that are smaller and of higher quality for the market for a new cryptocurrency, for example, where the available data is limited to one to two years.

3.3.2 Chronologicalized Feature Engineering

Fibonacci

Fibonacci sequences have been applied effectively to the trading in some cryptocurrencies, especially BTC/USD. We try to encode Fibonacci retracement and Fibonacci extension into the form of time series.

First, we use human knowledge to identify Fibonacci sequences in the cryptocurrency candlestick chart. Next, the program translates the Fibonacci sequence into data in the new time series and uses this feature set as a component of the system's state space.

For example, when the price of BTC/USD tests 261.8%, both Fibonacci and the Relative Strength Index signal bullish divergence. With this data in the state space, the model might learn to take action in buying BTC/USD. With only the Fibonacci feature set extracted, the model will learn to choose this action independently, and in fact the state at any one point will be composed of multiple features.

Accumulated Volume by Price

'Accumulated volume by price' reflects the psychology of traders in the market. Many professional traders operate by a theory that a sudden increase in the volume of a particular asset being traded at a particular time indicates either support for or resistance to the asset price. Whether the asset price moves higher or lower after the surge in volume indicates whether the market is providing support or resistance. Because the buy and sell orders created at these prices accumulate, a comparison of

support and resistance levels to market price indicates whether most traders are making a profit or loss.

Data for accumulated volume by price on the price axis is converted to indicate support and resistance on the time axis by converting this data into time-series features.

3.3.3 Mathematical Foundation used in Digital Asset Market

The model of the cryptocurrency robot we have developed is highly complex. In order to simplify the mathematical model we have developed, we have outlined a basic explanation of the complex system.

Feature Normalization

Before integrating primary features extracted from cryptocurrency market data into our state space, we need to normalize those features.

The goal of feature normalization is to resolve the problem of trading prices and trading volumes varying significantly across different cryptocurrencies. We want to normalize all the prices and volumes, including other technical indicators, so that they are in comparable ranges. To achieve this the following conditions must be satisfied:

- The normalized values are comparable across different stocks
- The normalized technical indicators should preserve their desired properties. For example, if an MACD value is greater than 0, then the normalized MACD value should also be greater than 0.
- To ease training of deep-learning models, the normalized feature values should lie between [-1, 1].

Some examples of normalization formula, where t denoted as time, are given below.

$$\text{norm\_candle}_t = \frac{\text{high}_t - \text{low}_t}{\text{open}_t}$$

$$\text{norm\_ema\_25\_day}_t = \frac{\text{ema\_25\_day}_t - \text{close}_t}{\text{close}_t}$$

$$\text{norm\_sd\_day}_t = \frac{\text{sd\_25\_day}_t}{\text{close}_t}$$

$$\text{norm\_volume}_t = \log_{10}\left(\frac{\text{volume\_sma\_5\_day}_t}{\text{volume\_sma\_25\_day}_t}\right)$$

From the above example, 'norm_ema_25_day' is positive whenever 'ema_25_day' is greater than the current close price and is negative

whenever 'ema_25_day' is less than the current close price. This illustrate the fact that this normalization formula will preserves the support-resistance property of 'ema_25_day'.

3.4 Portfolio Management

3.4.1 Markowitz Portfolio Theory

Let w_1 , w_2 , … , w_n be the weights or proportion of n different stocks in the portfolio and r_1, r_2, … , r_n be their corresponding expected returns. Let cov[i, j] be the covariance of stock i and stock j. We want to find the weights that maximize the expected return for a fixed variance σ2.

$$\text{maximize} \sum_{i=1}^{n} w_i \cdot r_i$$

subject to

$$\sum_{i=1}^{n} w_i = 1, \quad w_i \geq 0 \; \forall i = 1, \ldots, n$$

$$\sum_{\text{all } i,j} w_i \cdot w_j \cdot \text{cov}[i,j] \leq \sigma^2$$

To avoid a sudden change when rebalancing the portfolio over time, we sample the certain number of weights w_1, w_2, … , w_n from a Dirichlet distribution and search over that weight space w_1, w_2, … , w_n ~ Dirichlet((w1)+1 , (w2)+1 , … , (wn)+1)

3.4.2 Adjusted Risk per Trade Using Relative Strength

Using relative strength for adjusting risk per trade helps improve the empirical expected return.

$$\text{relative\_price}_i = \frac{\text{stock\_close\_price}_i}{\text{market\_close\_price}_i}$$

$$\text{relative\_strength\_25} = \frac{\text{relative\_price}_i - \text{relative\_price}_{i-25}}{\text{relative\_price}_{i-25}}$$

$$\text{risk\_per\_trade(x)} = \begin{cases} 0.05 & x < 0.0 \\ 1.5x + 0.05 & 0.0 \leq x < 0.1 \\ 0.20 & x \geq 0.1 \end{cases}$$

where x is the 25-day relative strength of the stock as defined above.

4. 'Wealth for All' Initiative

4.1 Financial Education Mechanism

CryptovationX aims to set up a committee of key collaborators in order to use a portion of the proceeds from our internal asset management to execute two main strategies: Financial Literacy Rewards and Sustainable Development Goals (SDGs).

The Financial Literacy Rewards program will encourage learning and self-improvement by incentivizing users to participate in the Prediction Game (see 2.2.3 Prediction Game) and hopefully address rising unemployment rates and narrow the widening income gap.

The Sustainable Development Goals (https://sustainabledevelopment.un.org/) is part of the United Nations' 2030 Agenda, which country members have been advocating since its launch in 2015. SDGs are a collection of goals set by the United Nations to address social and economic development issues. SDGs are targeted at all countries and not just limited to developing vis a vis developed countries.

4.1.1 Internal Digital Asset Management

Our liquidity management team will support the CryptovationX ecosystem and support these programs by using ETH and BTC as base assets and our platform's trade technology to implement trading strategies in different cryptocurrency markets. CryptovationX will prepare monthly reports with results of trading profits to be published on our official blog. With the help of AI technology, combined with our historical record of profitability, this strategy aims to generate a sustainable long-term source of income.

4.1.2 Financial Literacy Rewards

This program aims to incentivize everyone, regardless of gender, race, or age, to be educated and contribute to our Prediction Game feature (see 2.2.3 Prediction Game) by rewarding them with CXA tokens. The program will make use of a reputation ranking system so that, the more correct answers a Predictor provides, the larger number of tokens that Predictor will be rewarded.

The company will dedicate a portion of the proceeds of its liquidity and ecosystem management program sufficient to support and maintain the Financial Literacy Rewards program. In support of this commitment, the program will establish recurring Prediction Game contest periods and commit a portion of the accumulated proceeds as rewards to the contest

winners. All Predictors who successfully qualify during the timeframe will receive a share of the committed rewards.

4.1.3 Sustainable Development Goals (SDGs) Grant

CryptovationX intends for this program to reach and educate grassroot individuals about finance, investment, and technology. To achieve this corporate social responsibility goal, we will create an external committee to make available grants to suitable social projects. We have brought together several international development organizations and social enterprises to form the grant committee, including:

- **Asian Development Bank (ADB)'s NGO and Civil Society Centre** (https://www.adb.org/site/ngos/main) is an international development finance institution dedicated to reducing poverty in Asia and the Pacific. Since the late 1980s, the ADB has worked increasingly closely with civil society organizations. The ADB also has strategic collaborations with global NGO networks and often form collaborative projects with them.
- **Social Giver** (https://www.socialgiver.com) is a shopping platform which collaborates with businesses to channel profits made on the platform to social projects. The platform will allow purchaser to decide which project to contribute to.
- **Dress the Dream** (https://www.dressthedream.com/) is an initiative that prides itself on maintaining sustainable clothing by upcycling donated garments by people; proceeds of the initiative are donated to organizations committed to women's empowerment in Thailand.

4.2 Blockchain x AI Ecosystem

CryptovationX plans to release some source code publicly as a reference tool on Github for others who wish to pursue further development or to make their own robo-advisors. As time goes by, the older versions of 'Arbi', 'Specto', and 'Broca' will be released for public use, as well as the winning project from the 'Blockchain x AI Development Competition'. CryptovationX supports the idea of open source software as it can contribute to ecosystem building and knowledge sharing.

4.2.1 Blockchain x AI Conference

In order to stimulate young minds and provide an avenue for tech academics to showcase their work, CryptovationX wants to create a section of the Blockchain x AI Conference dedicated to academia. CryptovationX

will engage universities to hold sessions of Poster Presentations and Proceedings for their students, as well as to organize plenary sessions for tech professionals and entrepreneurs to talk about current events and share knowledge with participants.

In particular, the Asia School of Business, in collaboration with MIT's Sloan School of Management (http://www.asb.edu.my/), has shown interest in spearheading this academic conference as an exciting opportunity to learn more about innovation in the tech field. Professor Rajesh, one of our advisors and head of Innovation and Entrepreneurship Centre at MIT-ASB (http://www.asb.edu.my/innovation-entrepreneurship-center/), expressed keen interest in organizing in this academic conference. It can also serve as a recruiting opportunity for businesses who are looking to incubate talent.

4.2.2 Robo-advisory Competition

As part of our journey to constantly improve the CryptovationX platform, CryptovationX hopes that the robo-advisory competition will add valuable elements to our platform, by expanding beyond the initial concept, or redefine functions that have already been introduced. CryptovationX hope that through this competition, it can reduce the barriers of financial difficulty for talents that have the potential to grow into giant tech companies and help contribute to the development of Blockchain and AI globally.

Starting in 2019, CryptovationX will send out a list of requirements and select applicants to participate in the competition. During the first CryptovationX Robo-advisory Competition, CryptovationX will announce the nine shortlisted teams to develop more advanced versions of 'Arbi', 'Specto', and 'Broca', robo-advisors that can be integrated into our CryptovationX platform.

The nine shortlisted teams will then be incubated and sponsored with monthly funding. They will have one year to develop and test their prototypes, which will be showcased at the conference in 2020. CryptovationX will also organize bootcamps as a part of the incubation to bring together the teams and check on their progress throughout the year.

Winners of the competition will then be acquired by CryptovationX and their robo-advisors will be integrated into the platform. The winning teams will participate in a profit-sharing scheme with CryptovationX for the use of their robo-advisor.

4.2.3 Blockchain x AI Competition

The Blockchain x AI Development Competition is an idea CryptovationX proposed to provide a platform for new developers to showcase their talents or business ideas. In order not to restrict creative freedom, this competition will be less stringent, with no required theme for a featured product so long as it is blockchain- or AI-related.

There will be three teams that will be shortlisted and incubated with monthly funding of $10,000. The winning team will also be acquired by CryptovationX to further develop the technology.

Progress will be tracked by independent organizations, with a single representative from CryptovationX, to maintain transparency and fairness.

5. CryptovationX Tokens (CXA)

CryptovationX will issue CryptovationX Tokens (termed 'CXA') to utilize in the robo-advisory platform and its decentralized ecosystem.

5.1 Use of Tokens

There will be several levels of user accounts in the CryptovationX platform. Access to certain services such as automation and execution will be offered to users who reserve more tokens. However, to allow new users to gain access to features, they have to participate in our Prediction Game to earn CXA tokens.

Periodically, CryptovationX will reward consistent users of the platform with CXA tokens as their activities contribute directly to the development and improvement of the AI technology.

Ultimately, CryptovationX Tokens (CXA) will be used as a means to access the CryptovationX robo-advisory services - 'Arbi', 'Specto', and 'Broca'.

5.1.1 Platform One-time Membership Fee

As set out earlier in this paper, there will be several membership levels at which various services will be available to users. The levels come with different membership fees, which can be paid in CXA tokens. Each level is a lifetime membership purchasable at one time only. If the user would like to stop using service, the paid membership fee token will be refunded in full amount. There will be five levels at the following membership fees:

Level	One-time Membership Fee
Level 1	100 CXA
Level 2	1,000 CXA
Level 3	10,000 CXA
Level 4	100,000 CXA
Level 5	1,000,000 CXA

CXA members will be granted exclusive access to CryptovationX robo-advisory platform. Members will enjoy access to the services according to the various membership levels. Members can also use data

from the platform without being affected by the information received from the robo-advisors. Arbi, Specto, and Broca will assist some users in making profitable investment.

5.1.2 Payment for Premium Services

Users who wish to access certain 'Premium' services, such as customizations or the exclusive brokerage services offered by Broca, can choose to pay for such services using CXA. For example, users may want to participate in exclusive private sales, which are not normally available except through the premium function.

Advanced users may also purchase insight reports containing valuable investment information by simply paying a small fee in CXA. Additionally, users who want to improve the aesthetics and overall user experience of the platform can make in-platform purchases using CXA to customize the platform according to their preferences.

5.2 Token Sale

By releasing CXA tokens, we are offering all participants (traders, investors, analysts, data scientists, and the rest of the CryptovationX community) the chance to become creators of the decentralized CryptovationX ecosystem. CXA token holders can achieve different levels of access to the platform, with increased access to product features, depending on each holder's membership level, as well as use CXA tokens to pay for premium services.

5.2.1 Terms of Token Issuing

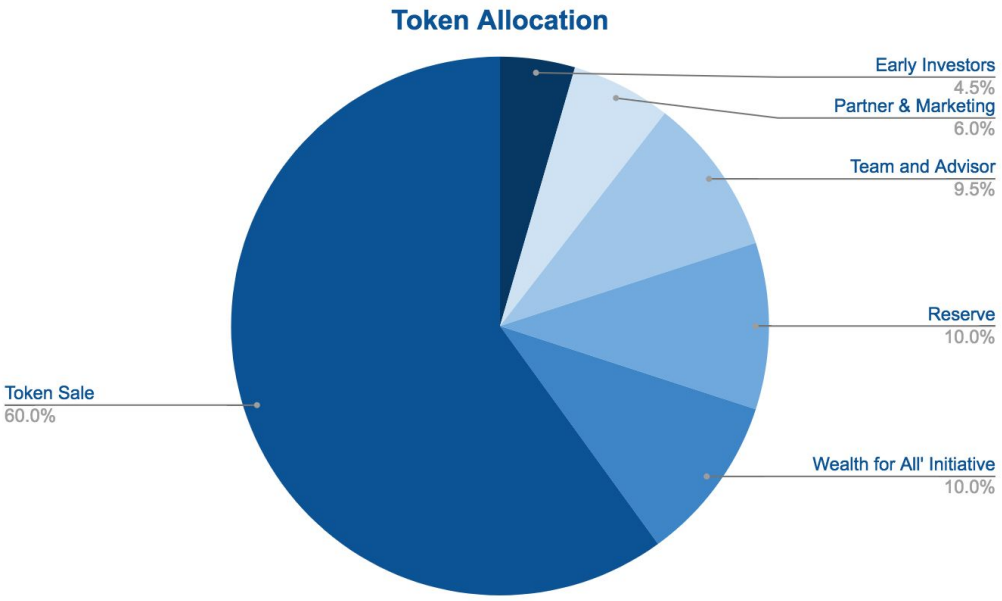
CXA tokens will be issued on the Ethereum blockchain using the ERC-20 token standard; 100% of the tokens will be issued prior to the token sale period. The total token supply is 12,000,000,000 CXA, of which 7,200,000,000 CXA tokens are for sale.

5.2.2 Token Sale Method

We plan to sell CXA tokens privately to high-net-worth individuals and institutional investors in order to avoid uncertainty and satisfy regulatory requirements. CXA tokens cannot be sold to residents of the United States of America, St. Kitts & Nevis, the People's Republic of China, [Thailand], or other countries where the sale of tokens may require registration as a security.

We will accept only ETH and BTC for the token sale. The price of the CXA token is 0.003 USD per token (this dollar price equivalent being provided for illustrative purposes only, as no fiat currency will be accepted for CXA tokens). The hard cap for the token sale is 21,600,000 USD.

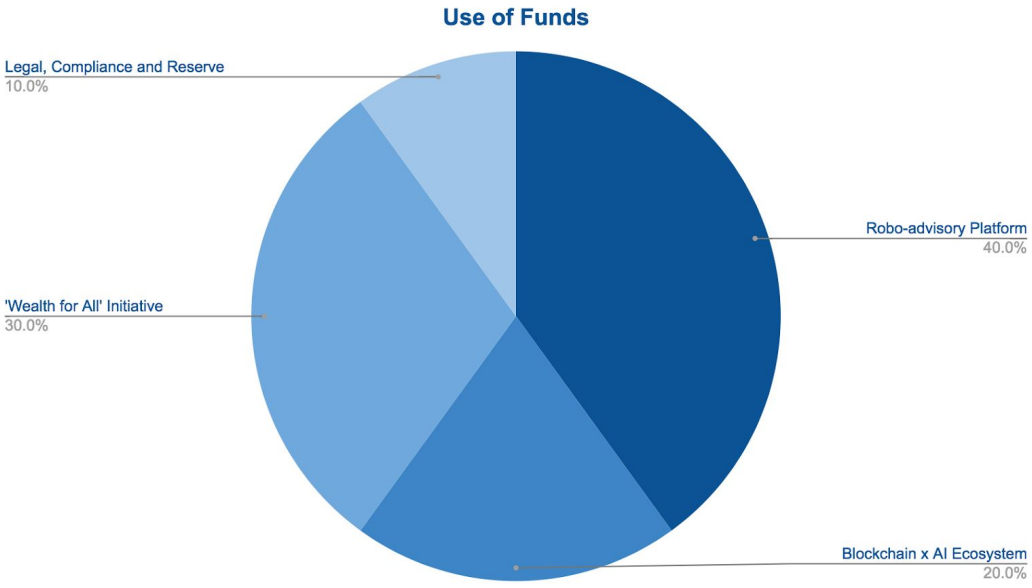
5.2.3 Token Allocation



Allocation		Percentage	Token
Token Sale Contributors		**60.0%**	**7,200,000,000**
Early Investors		**4.5%**	540,000,000
Partner & Marketing	Bounty	1.0%	120,000,000
	Airdrop	3.0%	360,000,000
	Strategic Partner	2.0%	240,000,000
	Total	**6.0%**	**720,000,000**
Organization	Team & Advisor	9.5%	1,140,000,000
	Reserve	10.0%	1,200,000,000
	'Wealth for all' Initiative	10.0%	1,200,000,000
	Total	**29.5%**	**3,540,000,000**
Total		**100.0%**	**12,000,000,000**

5.2.4 Use of Funds

Management of the funds will be broken down into four broad categories, namely 'Robo-advisory R&D', 'Blockchain x AI Ecosystem', internal asset management, and 'Reserves' which will be allocated as follows (proportions below are not final and may change at the company's discretion based on business needs).



40% **Robo-advisory Platform**: This portion of the budget is intended for the continuation of scientific work, infrastructure development, creation of new products, development of the robo-advisory platform. The budget will be allocated between these areas as set out below:

- Development: data science, AI modules, mobile applications, API, web-hosting, server capacity;
- Trading: trading services and terminals, development of trading algorithms and infrastructure;
- Operational costs: sustaining the business's day-to-day operations, salaries, office rent, other operational costs.

20% **Blockchain x AI Ecosystem:** Funds will go to support our annual Blockchain x AI Conference and providing supports for participants in the Robo-advisory Competition.

30% **'Wealth for All' Initiative**: This portion of the budget supports a portfolio for technology validation, the accumulation of valid trading data, and the formation of a dynamic motivational ETH/BTC pool for forecasters. The trades in this portfolio will also serve to make up a history of transactions, which will contribute to growing interest and demand for the robo-advisory platform.

10% **Legal, Compliance, and Reserve:** The budget will include legal support, improvement of the company's legal structure, and the protection of users' rights.

6. Roadmap

Year 2017 - Cryptovation		
Q1	Digital asset Arbitrage R&D	Research undertaken to identify strategies. Tested with real fund/s, manually traded/executed.
Q2	Arbot Development	Developed software to assist in trading
Q3	Wealth Management Service	Launched a service for professional investors
Q4	Reached 1 Million USD	Reached assets-under-management target
Year 2018 - CryptovationX (CXA) Private Token Sale		
Q1	CryptovationX partnership	Partnership development and community building
Q2	CryptovationX (CXA) Private Token Sale	Launch CXA to raise funds for further development
Q3	CXA Robo-advisory Platform (beta)	Launch the platform in iOS and Android for beta testing
Q4	CXA Robo-advisory Platform (1.0)	Upgrade the platform to full version
Year 2019 - Blockchain x AI Ecosystem		
Q1	1st Cryptovation Blockchain x AI Conference	Organize the event for knowledge sharing and launch the 1st Robo-advisory Competition
	Arbi, Specto, and Broca (beta)	Launch the platform extension for arbitrage, speculative trading, ICO investment for beta version
Q2	Arbi (1.0)	Upgrade Arbi to full version
Q3	Specto (1.0)	Upgrade Specto to full version
Q4	Broca (1.0)	Upgrade Broca to full version
Year 2020 - New Innovation and Beyond		
Q1	2nd Cryptovation Blockchain x AI Conference	Announce the winners for 2019's Robo-advisory Competition and launch the next competition

Q2	Winner Innovation	Integrate the winner innovation to the CXA robo-advisory platform
Q3	To be confirmed	

7. Team and Advisor

Management Team

Pondet Ananchai
Chief Executive Officer

Niran Pravithana
Chief Technology Officer

Richard Cayne
Chief Financial Officer

Erke Huang
Cheif Investment Officer

June Thatsanasateankit
Cheif Marketing Officer

Advisors

Rajesh Nair
Academic Advisor

Director, Innovation & Entrepreneurship Center, MIT Asia School of Business

Jason Corbett
Legal Advisor

Managing Partner, Blockchain Lawyer & FinTech, Silk Legal

Justin Wright
Strategy Advisor

Regional Head S.E. Asia, Beehive Asia

Shahar Rabin
Technology Advisor

Co-founder & CEO, Capitalise.ai

Sree Murthi
Technology Advisor

CEO, IT Spear Sdn Bhd

Joshua Ho
Business Advisor

Co-founder, QCP Capital

Arch Wongchindawest
Social Advisor

Founder & CEO, Socialgiver.com

Chaiwut Kovitchindachai
Strategy Advisor

Co-founder, AVA Advisory & Ex-executive Director, Prinsiri

References

1. Satoshi Nakamoto, (2018). Bitcoin: A Peer-to-peer Electronic Cash System, https://bitcoin.org/bitcoin.pdf.
2. Department of Economic and Social Affairs, (2013). World Economic and Social Survey 2013 Sustainable Development Challenges, https://sustainabledevelopment.un.org/content/documents/2843WESS2013.pdf
3. Julien Hamilton, (2015). Black Bird Bitcoin Arbitrage, https://github.com/butor/blackbird.
4. Ji Young Lee, Franck Dernoncourt, (2016). Sequential Short-Text Classification with Recurrent and Convolutional Neural Networks, https://arxiv.org/pdf/1603.03827.pdf.
5. Junyoung Chung, Caglar Gulcehre, KyungHyun Cho, Yoshua Bengio, (2014). Empirical Evaluation of Gated Recurrent Neural Networks on Sequence Modeling, https://arxiv.org/abs/1412.3555v1.
6. Kaiming He, Xiangyu Zhang, Shaoqing Ren, Jian Sun, (2015). Deep Residual Learning for Image Recognition, https://arxiv.org/abs/1512.03385
7. Harry Markowitz, (1952). Modern Portfolio Theory, http://www.math.ust.hk/~maykwok/courses/ma362/07F/markowitz_JF.pdf
8. Pierre Lévy, (1994). Collective Intelligence: Mankind's Emerging World in Cyberspace, https://dl.acm.org/citation.cfm?id=550283
9. Ngoc Thanh Nguyen (2011). Transactions on Computational Collective Intelligence III, https://www.springer.com/gp/book/9783642199677