Decision Tree Framework for Bitcoin Futures Position Management Based on Market Indicators

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Abstract— This paper presents a systematic approach to respond to a fast-paced, high-stakes, and volatile cryptocurrency market—especially Bitcoin futures contracts—by utilizing a concept in discrete mathematics known as a decision tree. The model requires market indicators—Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), and Exponential Moving Average (EMA)—and the investor's risk profile to evaluate the best outcome for a certain scenario in buying Bitcoin futures contracts. However, the model is highly simplified and requires further in-depth research for different scenarios. Further improvements and evaluation are necessary to achieve the best results.

Keywords—cryptocurrency, futures contract, decision tree

I. Introduction

Decision trees are a subfield of graph theory, widely applied as a decision-making framework because of their intuitive nature [1]. The core concept of a decision tree utilizes a set of rules for a few different scenarios or conditions. Tree components are nodes and edges. In this structure, the nodes of the tree represent a condition and the edges represent the possible outcome of that condition. For different values of market indicators, the result may vary, and the signal output may differ. In the context of market analysis, the nodes serve as validators for a specific threshold that has been set, while the branches lead to another validator which ends up in a corresponding investment action.

Because of these characteristics, a decision tree is perfect to assist investors in making their investment decisions by leveraging recent data to calculate the value of each indicator [2]. Market indicators such as the Relative Strength Index (RSI) or Moving Average Convergence Divergence (MACD) produce varying outputs depending on the current market conditions. Considering how the market changes dynamically, a decision tree is highly suitable for assisting investors in making consistent and data-driven trading decisions. It offers the flexibility and adaptability required by investors for different strategies under various market conditions.

Bitcoin was originally introduced by an anonymous individual known as Satoshi Nakamoto. Bitcoin adopts a concept known as a decentralized peer-to-peer international transaction. Its protocol relies on a secure concept known as blockchain. The blockchain is a public ledger secured by a cryptographic algorithm known as SHA-256, which forms the backbone of its Proof-of-Work (PoW) mechanism for "the miner" [3]. Because of the security, transparency, and direct nature it offers, Bitcoin has developed into a high-demand asset, despite its volatile price.

Futures contracts, on the other hand, are standardized legal agreements between two parties to buy or sell a certain commodity or asset at a predetermined price at a given specified time in the future. These contracts are typically used by traders or hedge fund managers to speculate on the price movement of a particular asset[4]. Bitcoin futures trading was first introduced on regulated U.S. exchanges in late 2017 by the Chicago Mercantile Exchange (CME). Since then, the number of exchanges that offer crypto futures has kept growing, offering investors a wider variety of platforms to trade on [5].

II. Theoretical Basis

A. Graph

1) Definition : A graph G is defined as a set of vertices (nodes) that are connected by edges. Graph vertices and edges are used to represent discrete objects and their relation. Graph can also be formally define as *G = (V, E)* which correspond to:

- *V* : Represent a set of finite non-empty vertices denoted as V = *{v1,v2,...,vn}*. The set v must not be empty.
- *E* : Represent a set of finite edges that connect a pairs of vertices denotde as E = *{e1,e2,...,en}*.The set of E can be empty.

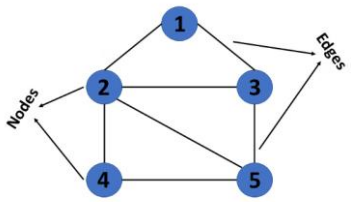

Fig. 1. Illustration of a graph
Source : https://www.simplilearn.com/tutorials/data-structure-tutorial/graphs-in-data-structure

A graph can also have multiple edges or paralel edges that connect two different vertices and an edges that connect to itself called loop.

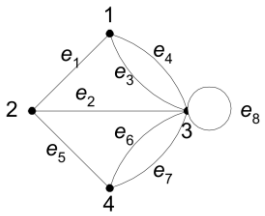

Fig. 2. Illustration of a graph that have multiple edges and loop
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

2) Types of Graph

Depending on the existence of loop and multiple edges, a graph can be divided into:

- *Simple Graph* : A graph which each of its vertices don't contain loop or multiple edges.
- *Unsimple Graph:* A graph which each of its vertices consists of multiple edges, loop, or both. A graph with multiple edges are called multi-graph and a graph with loops are called pseudo-graph.

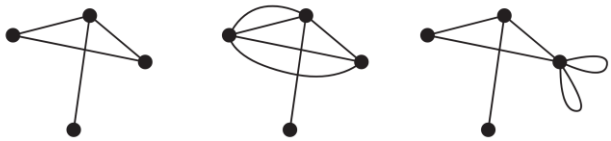

Fig. 3. Illustration simple and nonsimple graph
Source : https://mathworld.wolfram.com/SimpleGraph.html

A graph edges that connect two vertices can have weight associated with them. The weight may represent factors like cost or the distance required to travel between nodes.

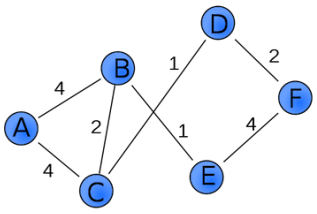

Fig. 4. Illustration of directed and undirected graph
Source : https://study.com/academy/lesson/weighted-graphs-implementation-dijkstra-algorithm.html

Depending on the graph orientation at the edges, graphs are divided into:

- *Undirected Graph : A graph which edges have no direction, representating a two-way relationships between vertices*
- *Directed Graph : A graph which edges have direction, representating a one-way relationship between vertices.*

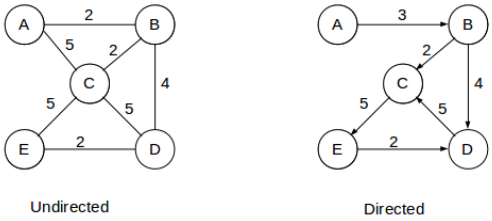

Fig. 5. Illustration of directed and undirected graph
Source : https://study.com/academy/lesson/weighted-graphs-implementation-dijkstra-algorithm.html

3) Terminology

a) Adjacent Vertices (Neighbors): Vertices are defined as adjacent if the two vertices directly connected by an edge.

b) Incidentcy: An edge is incident to the vertices if an edge is directly connects to a certain vertices.

c) Isolated Vertex: A vertex is defined as isolated if it completely disconnected from the graph or other vertices.

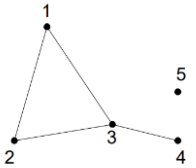

Fig. 6. Illustration of Null Graph
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

d) Null Graph (Empty Graph): A graphs are defined as null graph if it consist of vertices with no connecting edges.

e) Degree of a Vertex: Degree of a vertex is defined as the total number of edges connected to a vertex.

Handshake Lemma : The sum of all vertex degrees in a graph is always twice the total number of edges. This happens because each edge contributes exactly two degrees (one to each vertex it connects).

f) Path : A path is a sequence of vertices connected by edges, where each edge is used exactly once. The length of a path equals the number of edges it contains.

g) Cycle (Circuit): A cycle is a special type of path that begins and ends at the same vertex, forming a closed loop. Its length also equals the number of edges involved

h) Connectivity

- *Connected Graph :* A graph is connected if there is at least one path between every pair of vertices.

- *Disconnected Graph :* A graph with at least one pair of vertices that have no path connecting them, resulting in separate sections or components.

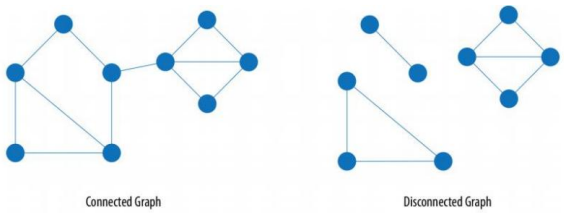

Fig. 7. Illustration of connected and disconnected graph
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

i) Cutset : A set of edges whose removal divides a connected graph into two separate disconnected components is called cutset..

j) Subgraph : A smaller graph formed by choosing certain vertices and edges from a larger graph.

k) Complement of a Subgraph : The resulting graph when the edges of a subgraph are removed from the original graph, leaving behind the remaining edges and vertices.

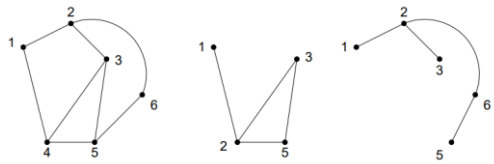

Fig. 8. Illustration of subgraph and its complement. The graph on the left is the original grap.
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

l) Spanning Subgraph : A subgraph is called a spanning subgraph if it consists of all the vertices of the original graph

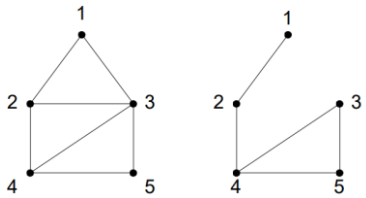

Fig. 9. Illustration of spanning subgraph.
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

B. Tree

1) Definition : A tree is a type of undirected graph that is connected and contains no cycles. This definition can be broken down into three essential conditions:

- The graph is undirected (edges have no direction).
- The graph is connected (there exists a path between every pair of vertices).
- The graph has no cycles (it does not contain any circular paths).

a) Forest : A forest is a disjoint set of trees. Formally, it is an undirected, acyclic graph that is not necessarily connected. Each connected component of a forest is a tree.

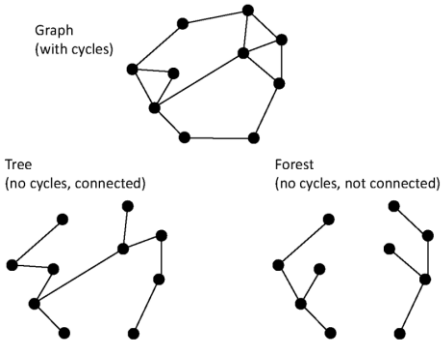

Fig. 10. Illustration of graph, tree, and forest.
Source : https://www.cambridge.org/core/books/abs/applying-graph-theory-in-ecological-research/shapes-of-graphs-trees-to-triangles/6F7A9487D10EF5ED28A83F7B035E7FDC

b) Spanning Tree : A spanning tree of a connected graph G is a subgraph that:

- Is a tree (connected and acyclic).
- Includes all the vertices of G.

Spanning trees are formed by removing edges that form cycles, while still maintaining connectivity.

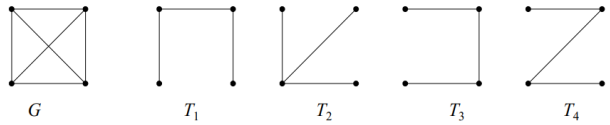

Fig. 11. Illustration of spanning tree
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/23-Pohon-Bag1-2024.pdf

c) Spanning Forest : A spanning forest is a collection of spanning trees, one for each connected component in a disconnected graph.

d) Rooted Tree : A rooted tree is a tree in which one vertex is designated as the root and all edges are directed away from the root, forming a hierarchical structure.

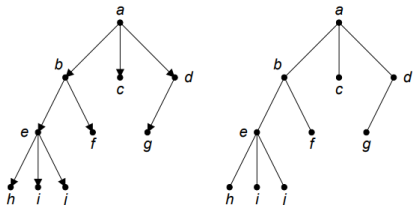

Fig. 12. Illustration of rooted tree
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/23-Pohon-Bag1-2024.pdf

e) Ordered Tree : An ordered tree is a rooted tree where the order of the children of each node matters. That is, changing the order of the children produces a different tree.

f) n-ary Tree : An n-ary tree is a rooted tree in which each node has at most children. A full n-ary tree is an n-ary tree where each non-leaf node has exactly children.

g) Binary Tree : A binary tree is a special case of an n-ary tree where . Each node has at most two children, commonly referred to as the left child and right child.

- *Full Binary Tree* : A binary tree in which every node, except leaf nodes, has exactly two children.
- *Complete Binary Tree* : A binary tree where all levels are fully filled except possibly the last, and the last level has all nodes as far left as possible.
- *Balanced Binary Tree* : A binary tree where the heights of the left and right subtrees of every node differ by at most one.
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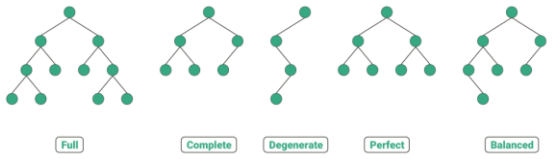

Fig. 13. Illustration of binary tree
Source : https://medium.com/data-science/5-types-of-binary-tree-with-cool-illustrations-9b335c430254

2) Applications of Trees

a) Binary Search Tree (BST): Used for fast data retrieval.

b) Parsing Expressions: Expression trees represent arithmetic expressions.

c) Prefix Coding: Huffman coding for data compression.

d) Decision Trees: Used in machine learning and logic modeling.

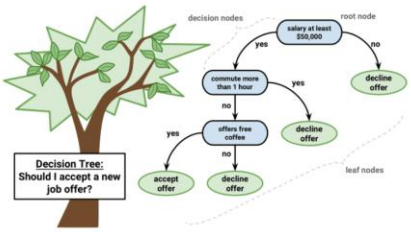

Fig. 14. Illustration of decision tree
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/24-Pohon-Bag2-2024.pdf

C. Market Indicators

1) Relative Strength Index (RSI) : Relative strength index (RSI) is a well-versed momentum oscilator to identify changes in momentom and price direction of a stocks or commodities. RSI measures the magnitude of recent price changes to detect whether a stocks or commodities are overbought or oversold [6]. The formula to calculate the value of RSI utilize recent gain or loss of an underlying asset during a set of period of time. The standard period to calculates RSI are 14 days. Calculating RSI requires two-part calculations.

a) Calculate the avarage gain and loss in 14 days.

$$RSI_{\text{step one}} = 100 - \left[\frac{100}{1+\frac{\text{Average gain}}{\text{Average loss}}}\right]$$

b) After collecting 14 periods of data. Another calculation can be done to get the result of the RSI.

$$RSI_{\text{step two}} = 100 - \left[\frac{100}{1+\frac{(\text{Previous Average Gain}\times 13)+\text{Current Gain}}{(\text{Previous Average Loss}\times 13)+\text{Current Loss}}}\right]$$

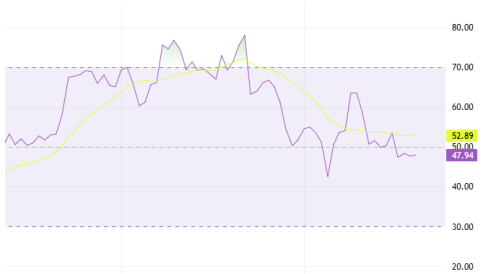

Fig. 15. Illustration of RSI indicators
Source : https://www.tradingview.com/chart/htElxjfk/?symbol=BITSTAMP%3ABTCUSD

What to look for : When a price momentum rose rapidly in a short amount of time, the underlying financial instruments or asset would eventually be considered overbought and would be the best time to sell the underlying asset. Likewise, when prices dropped rapidly in a short amount of time and momentum was low enough, the financial

instrument would at some point be considered oversold presenting a possible buying opportunity. There are a set number of RSI that are commonly used in real world situations. Any number above the value of 70 should be considered overbought and any number below the value of 30 should be considered oversold. However, those ranges of numbers are not strict, some traders may even decrease or increase according to their trading strategy [7].

Other RSI common feature :

- *Divergence* : RSI divergence occurs when there is a difference between the price action value and the RSI value. These differences can be interpreted as an impending reverseal. There are two types of divergences that can occur :
  - *Bullish RSI Divergence* : When price makes a new low but RSI makes a higher low.
  - *Bearish RSI Divergence* : When price makes a new high but RSI makes a lower high.

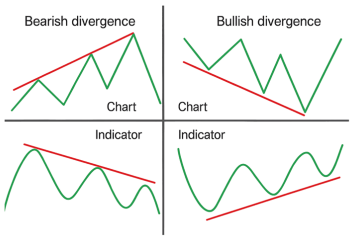

Fig. 16. Illustration of RSI divergences
Source : https://www.kavout.com/market-lens/unlock-peak-profits-mastering-rsi-and-macd-divergence-in-crypto-and-forex

- *Failure Swings* : Failure Swings are another occurences in RSI that indicate a price reversal. There two types of failure swings and each of them consists of four steps :
  - *Bullish Failure Swing*
    - RSI drops below 30 (considered oversold).
    - RSI bounces back above 30.
    - RSI pulls back but remains above 30 (remains above oversold)
    - RSI breaks out above its previous high.
  - *Bearish Failure Swing*
    - RSI rises above 70 (considered overbought)
    - RSI drops back below 70
    - RSI rises slightly but remains below 70 (remains below overbought)
    - RSI drops lower than its previous low.

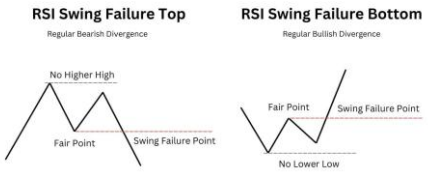

Fig. 17. Illustration of RSI failures swings
Source : https://alchemymarkets.com/education/indicators/the-rsi-divergence-explained/

2) Exponential Moving Average (EMA) : A specific type of moving average that represents an asset/commodities price changes at the most recent time period. Unlike other moving average, EMA indicators emphasizes on recent prices than historical data. The primary objective of of this indicator is to identify trends in prices and determine the value of resistance and support bands. EMAs with a period of 12 and 26-day are also used to create other indicators. For example, moving average convergernce and divergence (MACD) and percentage price oscillator. A combination of multiple indicators combine with EMA produce an insight of the market trends.

EMA line are frequently use by trader and investor to identify the market trends because of its sensitivity to price changes. This insight will help investors to determine their investing plan and move accordingly. EMA indicators follow the current trends in price. When the EMA line goes upward, it represent the uptrend, whereas when it goes in the downtred, it represent the downtrend of the price movement. The position of EMA also have a meaning. When EMA indicators located above assets's current market price, it will result in a downtrend and it work the other way around [8]. The formula for EMA is shown below with the smoothing value commonly set to the value of two.

$$EMA_{Today} = (Value_{Today} \times (\frac{Smoothing}{1 + Days})) + EMA_{Yesterday} \times (1 - (\frac{Smoothing}{1 + Days}))$$

What to look for : EMA indicators is defferent than other moving avarage indicators. EMA strives to help traders set their preferred time to enter or exit the market pass before the moving average even shows changes. EMA emphasizes on the most recent data. Therefore, price movement and trend reversals or changes are closely monitored allowing traders to spot and react quicker than other moving averages.

Fig. 18. Illustration of EMA indicators. The blue line is the EMA indicator
Source :
https://www.tradingview.com/chart/htElxjfk/?symbol=BITSTAMP%3ABTCUSD

3) Moving Average Convergence/Divergence (MACD) : Moving average convergence/divergence (MACD) is a technical indicator to help investors identify a variety of price trends, price momentum, and entry points for buying or selling a certain asset or commodities. MACD indicator is and indicators that shows the relationships between two exponential moving averages (EMAs) of asset prices. The MACD line is calculated by subtracting the 26-period EMA from the 12-period EMA. Traders will potentially buy a certain asset when its MACD line croses above the signal line and sell the asset when the MACD line crosses below the signal line. MACD indicators interpretation may vary, however there are a more common methods for it. A few of them includes crossovers, divergences, and rapid rises/falls [9].

The MACD calculation consists of a three components

- *MACD Line = 12-day EMA – 26-day EMA*
- *Signal Line = 9-day EMA* ***of MACD Line***
- *MACD Histogram = MACD Line – Signal Line*

A general interpretation of MACD indicator is that when MACD is positive and the histogram value seems like it's increasing, then upside momentum is increasing. When MACD is negative and the histogram value is decreasing, then downside momentum is increasing.

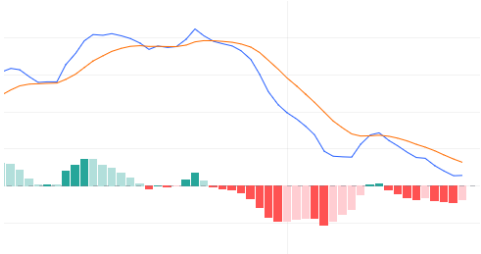

Fig. 19. Illustration of MACD indicators. The blue line is the MACD indicator, whereas the yellow line is the signa line
Source :
https://www.tradingview.com/chart/htElxjfk/?symbol=BITSTAMP%3ABTCUSD

What to look for : MACD indicators is typically used for investor to identify three types of basic signal in the market.

- *Single Line Crossover*
  - *Bullish Single Line Crossover* : Occur when the MACD line move its position from below to above the single line.
  - *Bearish Single Line Crossover* : Occur when the MACD line move its position from above to below the singe line.

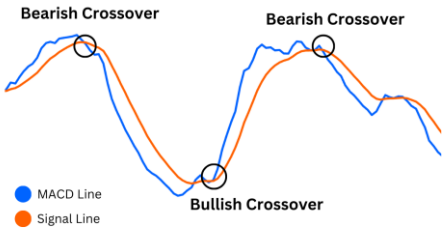

Fig. 20. Illustration of bullish and bearish single line crossover
Source :
https://alchemymarkets.com/education/indicators/macd/

- *Zero Line Crossover*
  - *Bullish Zero Line Crossover* : Occur when the MACD Line crosses above the Zero Line and go from negative to positive.
  - *Bearish Zero Line Crossover* : Occur when the MACD Line crosses below the Zero Line and go from positive to negative.

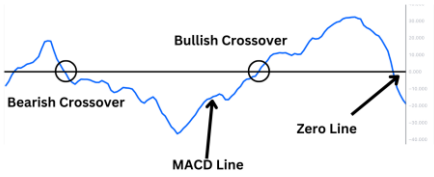

Fig. 21. Illustration of bullish and bearish zero line crossover:
Source :
https://alchemymarkets.com/education/indicators/macd/

- Divergence
  - *Bullish Divergence* : Occurs when price records a lower low, but the MACD records a higher low.ccurs when price records a lower low, but the MACD records a higher low.
  - *Bearish Divergence* : Occurs when price records a higher high while the MACD records a lower high.

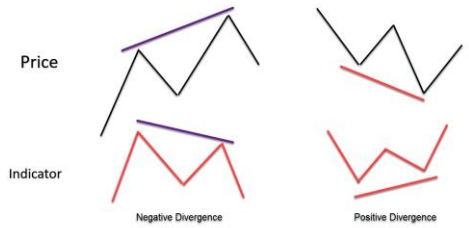

Fig. 22. Illustration of bullish and bearish divergence
Source : https://alchemymarkets.com/education/indicators/macd/

III. Data Preparation

A. Data Description

This research utilizes a dataset from Kaggle, consisting the most recent data available since 2018. Only a one-day timeframe is used, and specific dates are selected according to predefined scenarios. The dataset attributes include: :

- *Open time* : The start timestamp of the candlestick interval. Example: 2018-01-01 indicates the beginning of the trading session for that day.
- *Open* : The opening price of the Bitcoin futures contract at the beginning of the interval. Example: 13715.65 USD was the first traded price of the day.
- *High* : The highest price reached during the interval. Example: 13818.55 USD represents the price peak for that day.
- *Low* : The lowest price recorded during the interval. Example: 12750.0 USD is the lowest point the price reached during the session.
- *Close* : The last traded price before the candlestick interval ended. Example: 13380.0 USD was the final price of the day.
- *Volume* : The total volume of Bitcoin traded during the interval, expressed in base asset units (BTC). Example: 8609.915844 BTC.
- *Close time* : The timestamp marking the end of the candlestick interval. Example: 2018-01-01 23:59:59.999 indicates the end of the daily candle.
- *Quote asset volume* : The total traded volume in the quote currency (typically USD or USDT). Example: 114799747.44197056 USD shows the total monetary value of the day's trades.
- *Number of trades* : The total number of executed trades during the interval. Example: 105595 trades occurred during the trading session.
- *Taker buy base asset volume* : The amount of Bitcoin purchased by takers (market order buyers) during the interval. Example: 3961.938946 BTC were aggressively bought by takers.
- *Taker buy quote asset volume* : The total quote currency value of the taker buy trades. Example: 52809747.44038045 USD was spent by takers in market orders.

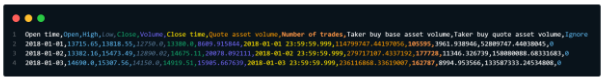

Fig. 23. Sample of Dataset
Source : https://www.kaggle.com/datasets/novandraanugrah/bitcoin-historical-datasets-2018-2024

B. Calculation of Market Indicators

The market indicators used in this research consist of the Relative Strength Index (RSI), Exponential Moving Average (EMA), and Moving Average Convergence Divergence (MACD). All calculations are performed automatically using the Python programming language. In this study, the EMA is calculated with a period of 50 days, while the MACD is computed based on the difference between the 12-day and 26-day EMAs. The configuration of trading indicator parameters may vary depending on individual trader preferences.

a) RSI

```python
def compute_rsi(series, period=14):
    delta = series.diff()
    gain = delta.where(delta > 0, 0).rolling(period).mean()
    loss = -delta.where(delta < 0, 0).rolling(period).mean()
    rs = gain / loss
    return 100 - (100 / (1 + rs))

df['RSI'] = compute_rsi(df['Close'])
```

Fig. 24. RSI Calculation
Source : Writes's code

b) EMA

```python
df['EMA_50'] = df['Close'].ewm(span=50, adjust=False).mean()
```

Fig. 25. EMA Calculation
Source : Writes's code

c) MACD

```python
ema_12 = df['Close'].ewm(span=12, adjust=False).mean()
ema_26 = df['Close'].ewm(span=26, adjust=False).mean()
df['MACD'] = ema_12 - ema_26
df['MACD_signal'] = df['MACD'].ewm(span=9, adjust=False).mean()
df['MACD_histogram'] = df['MACD'] - df['MACD_signal']
```

Fig. 26. MACD Calculation
Source : Writes's code

IV. IMPLEMENTATION

The decision tree utilized in this research is a simplified algorithm of real-world trading logic. In real world scenario, decision trees for financial trading can involve numerous scenarios, branches, and conditional checks, ranging from technical indicators and macroeconomic data, to behavioral condition of the market. However, to maintain clarity and simplicity, only a certain market indicators decision criteria were included. The tree is constructed as a decision tree structure, where each node evaluates specific market indicators—namely RSI, EMA, and MACD—and routes the decision toward one of three final signals: Long (Buy), Short (Sell), or Hold (Neutral).

The tree diagram will be separated to two different pictures for readability. The first picture is the scenario if the closing price is greater than EMA.

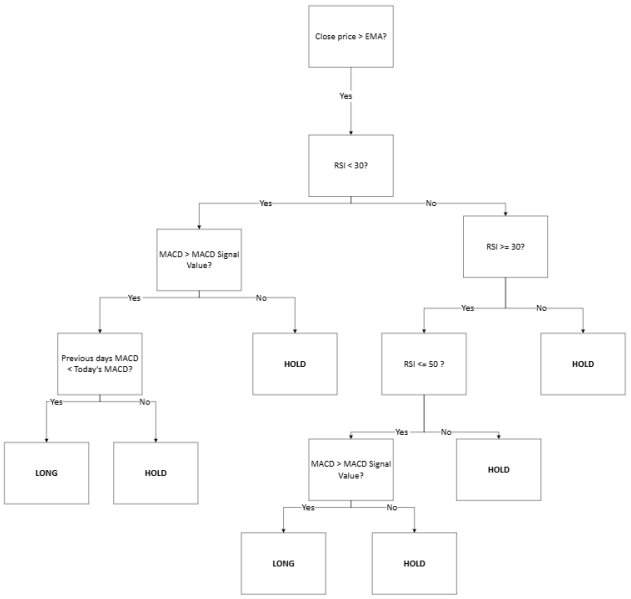

Fig. 27. Tree structure
Source : Writes's code

the other hand the second picture shows the scenario if the closing price is smaller or equal the EMA value.

Fig. 28. Tree structure
Source : Writes's code

The decision tree logic evaluated sequentially to determine one of three trading signals. The first and most fundamental condition is to examine whether the current closing price is above the 50-day Exponential Moving Average (EMA-50). This correspond to the general market bias, because if the closing price is above EMA-50, the market is interpreted as bullish. Otherwise, it is treated as bearish.

In a bullish scenario (price above EMA-50), the function evaluates the Relative Strength Index (RSI). If the RSI is below 30, this indicates an oversold condition. The function then checks if the MACD line is above its signal line (suggesting bullish momentum), and if the MACD histogram is increasing compared to the previous day (signaling strengthening momentum). If all these conditions are met, a LONG signal is returned. If only some of these conditions are satisfied, the result defaults to HOLD Alternatively, if the RSI is between 30 and 50 and the MACD is above the signal line, another LONG signal is issued. Otherwise, it results in HOLD signal.

In a bearish scenario (price below EMA-50), the same logic applies in reverse. If the RSI is above 70, this suggests an overbought condition. The function then checks whether the MACD is below its signal line (bearish momentum) and if the MACD histogram is falling (momentum weakening). If these conditions are met, a SHORT signal is returned. If the RSI is between 50 and 70 and the MACD is still below the signal line, the function returns a SHORT signal. Any mismatch in conditions—such as lack of confirmation from momentum indicators, results in a HOLD, indicating no action should be taken

The code implementation for the decision tree using python programming language.

```python
def rule(row, prev):
    above = row['Close'] > row['EMA_50']
    bull = row['MACD'] > row['MACD_signal']
    bear = row['MACD'] < row['MACD_signal']
    hist_up = prev is not None and row['MACD_hist'] > prev['MACD_hist']
    hist_down = prev is not None and row['MACD_hist'] < prev['MACD_hist']

    if above:
        if row['RSI'] < 30:
            if bull:
                if hist_up:
                    return 1
                else:
                    return 0
            else:
                return 0
        else:
            if row['RSI'] >= 30:
                if row['RSI'] <= 50:
                    if bull:
                        return 1
                    else:
                        return 0
                else:
                    return 0
            else:
                return 0
    else:
        if row['RSI'] > 70:
            if bear:
                if hist_down:
                    return -1
                else:
                    return 0
            else:
                return 0
        else:
            if row['RSI'] >= 50:
                if row['RSI'] <= 70:
                    if bear:
                        return -1
                    else:
                        return 0
                else:
                    return 0
            else:
                return 0
```

Fig. 29. Tree code
Source : Writes's code

V. Result and Discussion

To evaluate the accuracy of the logic used in the binary decision tree, a set of random dates was selected to test the profit or loss resulting from following the signals generated by the program. For each test case, the initial trading capital is set to be $1,000. The profit or loss is calculated by comparing the closing price on the selected date with the closing price one week later. Bitcoin futures also offer leverage options to increase the gains (or losses). In this research, the author applies a 20× leverage, meaning that the effective trade size becomes $20,000. This approach allows for a clearer observation of potential gains and losses when trading Bitcoin futures.

1) 2024-12-23

```
Available date range: 2018-01-14 to 2025-06-18
Enter target date (YYYY-MM-DD): 2024-12-23

Signal for 2024-12-23:
  Close          : 94881.47 USD
  EMA-50         : 92487.28
  RSI            : 45.09
  MACD           : 1016.25
  MACD Signal    : 2379.02
  MACD Histogram : -1362.77
  Decision       : ⏸ HOLD
```

Fig. 30. Result of testcase
Source : Writes's code

2) *2025-02-18*

```
Available date range: 2018-01-14 to 2025-06-18
Enter target date (YYYY-MM-DD): 2025-02-18

Signal for 2025-02-18:
  Close          : 96105.38 USD
  EMA-50         : 97897.43
  RSI            : 43.25
  MACD           : -923.92
  MACD Signal    : -804.51
  MACD Histogram : -119.42
  Decision       : 📉 SHORT
```

Fig. 31. Result of testcase
Source : Writes's code

Price on 2025-02-25 : $92080.93
Profit/Loss : $838.90 USD.

3) *2025-04-07*

```
Available date range: 2018-01-14 to 2025-06-18
Enter target date (YYYY-MM-DD): 2025-04-07

Signal for 2025-04-07:
  Close          : 79216.47 USD
  EMA-50         : 86882.37
  RSI            : 33.22
  MACD           : -1244.25
  MACD Signal    : -1052.61
  MACD Histogram : -191.63
  Decision       : ⏸ HOLD
```

Fig. 32. Result of testcase
Source : Writes's code

4) *2025-05-25*

```
Available date range: 2018-01-14 to 2025-06-18
Enter target date (YYYY-MM-DD): 2025-05-25

Signal for 2025-05-25:
  Close          : 107584.73 USD
  EMA-50         : 97760.05
  RSI            : 59.63
  MACD           : 3868.30
  MACD Signal    : 3856.55
  MACD Histogram : 11.75
  Decision       : 📈 LONG
```

Fig. 33. Result of testcase
Source : Writes's code

Price on 2025-06-01 : $ 104194.55
Profit/Loss : –$629.84USD

5) *2025-06-17*

```
Available date range: 2018-01-14 to 2025-06-18
Enter target date (YYYY-MM-DD): 2025-06-17

Signal for 2025-06-17:
  Close          : 107107.09 USD
  EMA-50         : 102826.27
  RSI            : 51.43
  MACD           : 716.54
  MACD Signal    : 961.80
  MACD Histogram : -245.26
  Decision       : ⏸ HOLD
```

Fig. 34. Result of testcase
Source : Writes's code

Date	Position	PnL
2024-12-23	HOLD	-
2025-02-18	SHORT	+83.89%
2025-04-07	HOLD	-
2025-05-25	LONG	–62.98%
2025-06-17	HOLD	-

The results obtained from the program initially looks promising, however, further testing reveals that the model tends to generate a high number of HOLD signals. This behavior is the consequences of the strict thresholds defined for the RSI, EMA, and MACD indicators. While this conservative approach helps reduce false signals, it also limits trading opportunities. If a trader/investors prefers a more active strategy favoring more frequent LONG or SHORT positions the decision criteria can be adjusted accordingly. For instance, the sensitivity of the RSI or the confirmation requirements of MACD crossovers can be increase or decrease dynamically based on the trader's risk profile or market conditions. Nevertheless, test cases also show that overly aggressive assumptions resulting in losses. This is also a reminder for investor or trader to never relies fully on data, rather take into account the unkown variable in the market. While the model provides a functional starting point, it requires further refinement and scenario-based testing to improve its robustness and practical applicability.

VI. CONCLUSION

This research demonstrates a basic implementation of a decision-tree-based trading strategy for Bitcoin futures using RSI, MACD, and EMA indicators. By utilizing technical market indicators into decision outcomes (LONG, HOLD, SHORT), it provides rule-based framework suitable for beginner-level exploration of algorithmic trading models. However, the current implementation is simplified. It does not account complex market dynamics, risk-adjusted portfolio sizing, multiple indicator cross-validations, or broader contextual data such as volume anomalies or news sentiment. Therefore, while the program offers a useful starting point, further enhancement is required to address more realistic and diversified trading scenarios.

VII. APPENDIX

Source Code : https://github.com/staplesmaster/Makalah-Matematika-Diskrit

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STATEMENT

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Bandung, 1 Juni 2025

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