Study the Growth of Cryptocurrency and Predicting its Future

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I. EXECUTIVE SUMMARY

This comprehensive study delves into the volatile cryptocurrency landscape, focusing on historical price trends and forecasting future movements. The top five cryptocurrency coins are explored in terms of volatility. This study also explores different Predictive Modelling techniques including Support Vector Regression for in-depth analysis. Moving Average Prediction Models are also being tested to provide insights into potential future trajectories. The study's goal is to provide useful insights into the evolving world of cryptocurrency, laying the groundwork for informed decision-making and strategic investment considerations.

II. BACKGROUND

A. *What is Cryptocurrency?*

Cryptocurrency is decentralized digital money designed to be used over the Internet that works on Blockchain. Peer-to-peer technology makes it possible for anybody, anywhere, to give and receive money. Digital entries to an online database detailing individual transactions are the only thing that cryptocurrency payments are made with, as opposed to actual money that is carried and exchanged in the real world. A public ledger keeps track of all cryptocurrency transactions that take place when money is transferred. Crypto wallets are used to store cryptocurrency [1].

B. *What is a Blockchain and how does it work?*

A blockchain is a distributed ledger or database that is shared by all nodes in a computer network. Though they have applications outside of cryptocurrencies, they are most recognized for playing a critical part in cryptocurrency systems that preserve a safe and decentralized record of transactions. Any industry can use blockchain technology to make data immutable, or incapable of being changed [2].

The two most widely used methods for creating a blockchain block and validating transactions are known as proof of stake and proof of work. These are the procedures that nodes in a specific blockchain network use to reach consensus. Recall that blockchain-based cryptocurrencies employ various verification mechanisms with distinct architectures.

Proof of work is the first and most widely used method of proving transactions, and it is utilized by several well-known cryptocurrencies, such as Ethereum and Bitcoin. When miners solve a mathematical puzzle, proof of work validates the transaction, adding a new block to the chain and creating new coins (just think of Bitcoin miners for example). Miners are in charge of supplying more of some digital currencies to the market.

In essence, mining is a highly computationally intensive and energy-intensive process that involves guesswork. As the block is added to the blockchain, the miner who solves a challenging mathematical puzzle involving the hashed data the fastest will receive a certain quantity of cryptocurrency as payment.

In contrast, validators use proof of stake "stake" cryptocurrency on a particular transaction to create a block. Through the act of staking their assets, participants are put into a lottery-style selection process. Should they be selected, the validator will be compensated with the transaction costs.

Because proof of stake requires less aggregated processing power, it is generally more equitable because individuals with greater resources are not able to control the verification process, as is frequently the case with proof of work systems. Because of how compelling the system is, Ethereum plans to switch to a proof of stake in 2022. However, in the absence of proof of stake systems' mining function, all the currency must be pre-mined as opposed to steadily mining and producing coins like Bitcoin.

C. *How are Cryptocurrencies created?*

The technique by which cryptocurrency is created is called mining. Cryptocurrency transactions must be verified, and mining both generates new cryptocurrency and carries out the verification. Mining is the process of adding transactions to the blockchain using specialized hardware and software. Not every coin is produced by mining. Cryptocurrency, for instance, that is not spendable is not mined. Instead, a hard fork is used by engineers to produce the new currency. A blockchain hard fork forms a new chain. While one branch takes the new route, the other stays on the previous one. Generally, cryptocurrency that isn't mineable is employed for investments rather than purchases [3].

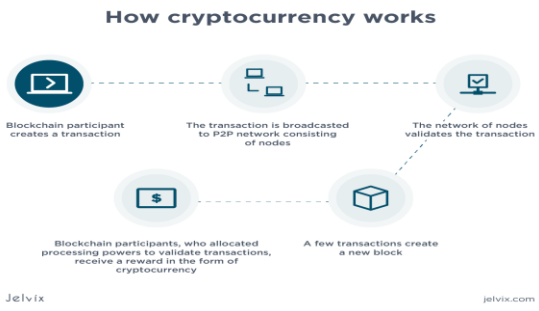

Fig. 1. Describes how cryptocurrency works [4]

D. *What are Cryptocurrency Exchanges?*

A Cryptocurrency exchange is a digital marketplace that facilitate the buying and selling of virtual currencies like Tether, Ethereum, and Bitcoin by investors. These platforms operate through PC features like e-brokerages or through digital marketplaces like mobile apps. They also give their consumers access to a variety of trading and investing tools [5]. The cryptocurrency exchanges also offer futures and options trading, margin or lending trading, and trading of different cryptocurrencies. The cryptocurrency exchanges charge a fee for your transactions, which varies depending on the sort of deal you made and the volume of the transaction, to support their users with these endless services.

E. *What are Crypto Wallets and why they are important?*

With cryptocurrency wallets, you can transfer and receive digital currencies like Ethereum and Bitcoin while keeping your private keys—the passwords that grant you access to your cryptocurrency holdings—safe and secure. They are available in a variety of formats, including mobile apps like Coinbase Wallet that make using cryptocurrency as simple as using a credit card for online purchases, and hardware wallets like Ledger, which resemble USB sticks [6].

In theory, crypto wallets don't store your cryptocurrency, unlike a regular wallet, which can house real cash. Your assets are stored on the blockchain and are only accessible with a private key. Your keys let you conduct transactions and serve as identification of who owns your digital currency. You cannot access your money if you misplace your private keys.

F. *Cryptocurrency Terms*

To understand the data in cryptocurrencies, it is necessary to know some terms related to it.

1) *Open*

The price of a cryptocurrency at the start of a given trading period, such as a day, week, or month, is referred to as the opening price. When the market opens following a prior closing period, this is the first price that has been recorded.

2) *High*

The high price is the maximum value that a cryptocurrency can achieve in a specific amount of time. For example, the peak price attained in each day or trading session.

3) *Low*

This is the lowest value a cryptocurrency can achieve within a specific time frame, which is the opposite of a high price. It represents the lowest price the asset reached in that period.

4) *Close*

The price at which a cryptocurrency trades at the end of a specific time frame, like a day, week, or month, is referred to as the closing price. It is the final price that has been noted before the market closes.

5) *Volume*

Volume is a term used to describe the total amount of a particular cryptocurrency that has been traded in a given time frame, typically 24 hours.

6) *Marketcap*

This is cryptocurrency's total value. It is computed by multiplying the total number of coins or tokens in circulation by the cryptocurrency's current price. A cryptocurrency's size and relative worth in relation to other coins on the market are frequently determined using its market capitalization.

7) *All-Time High (ATH)*

The highest price a cryptocurrency has ever seen during its whole trading history is denoted by this. It represents the asset's highest value attained.

8) *All-Time Low (ATL)*

An asset's all-time low is the lowest price it has ever been since it started trading on an exchange. It represents the asset's lowest value to date.

III. ANALYSIS

A. *Data Collection and Preparation*

Data collection is one of the most important parts of data visualization and future prediction. Without accurate and comprehensive data, the effectiveness of data visualization and future prediction would be severely compromised. It serves as the foundation upon which meaningful insights and informed decisions can be made. Additionally, data collection enables organizations to identify patterns, trends, and correlations that can lead to valuable discoveries and strategic planning.

We need continuous data that can provide historical day-to-day transactions in cryptocurrencies.

To collect the data, we used Coinmarketcap for the historical data of five coins through Web Scraping, CoinGecko for real-time data through API, and CryptoCompare for Exchanges data. These data sources are highly reliable and provide useful data.

```
import requests
import pandas as pd
from pandas import json_normalize
from IPython.display import FileLink
import time  # Import the time module

pd.set_option('display.float_format', '{:.2f}'.format)

# Get the current epoch time
current_epoch_time = int(time.time())

# Define date range in chunks
date_chunks = [
    (1546214400, 1577836799),  # January 1, 2019, to December 31, 2019
    (1577750400, 1609459199),  # January 1, 2020, to December 31, 2020
    (1609372800, 1640995199),  # January 1, 2021, to December 31, 2021
    (1640912400, 1672448400),  # January 1, 2022, to December 31, 2022
    # Add more chunks if needed
    # The last chunk goes up to the current date
    (1672448400, current_epoch_time),  # From January 1, 2023, to current date
]

# Initialize an empty DataFrame to store the results
df_list = []

# Make requests for each date range
for start_time, end_time in date_chunks:
    url = f'https://api.coinmarketcap.com/data-api/v3.1/cryptocurrency/historical?id=1&convertId=2781&timeStart={start_time}
    response = requests.get(url)

    if response.status_code == 200:
        data = response.json()['data']['quotes']
        df_chunk = json_normalize(data)
        df_list.append(df_chunk)
    else:
        print(f'Error: {response.status_code}')
        print(response.text)

# Concatenate the DataFrames
df = pd.concat(df_list, ignore_index=True)

# json to Excel file
excel_file_path = 'bitcoin_original.xlsx'
df.to_excel(excel_file_path, index_label='index')

print(f'Data has been exported to {excel_file_path}')
FileLink(excel_file_path)
```

```
Data has been exported to bitcoin_original.xlsx
```

bitcoin_original.xlsx

Fig. 2. Represents the Data Model

```
import pandas as pd

# Read the Excel file
df = pd.read_excel(r"C:\Users\mahes\Downloads\bitcoin_original.xlsx")
df['date'] = pd.to_datetime(df['timeOpen'], format='%Y-%m-%dT%H:%M:%S.%fZ')

# Create a new DataFrame with the formatted date and primary key
date_table = pd.DataFrame({
    'date': df['date'],
    'formatted_date': df['date'].dt.strftime('%Y-%m-%d'),
    'primary_key': df['date'].dt.strftime('%Y%m%d').astype(int)
})

# Convert 'date' column to pandas datetime format
df['start_time'] = pd.to_datetime(df['timeOpen'], format='%Y-%m-%dT%H:%M:%S.%fZ'
df['end_time'] = pd.to_datetime(df['timeClose'], format='%Y-%m-%dT%H:%M:%S.%fZ')

# Create a new DataFrame with the formatted date and primary key
date_table = pd.DataFrame({
    'date_Id': df['start_time'].dt.strftime('%Y%m%d').astype(int),
    'date': df['start_time'].dt.strftime('%Y-%m-%d'),
    'start_time': df['start_time'],
    'end_time': df['end_time']
})

# Save the new DataFrame to a new Excel file
date_table.to_excel(r"C:\Users\mahes\Downloads\date_table.xlsx", index=False)

print(f'Data has been exported')
print(date_table.head())
```

```
Data has been exported
    date_Id        date start_time               end_time
0  20190101  2019-01-01 2019-01-01 2019-01-01 23:59:59.999
1  20190102  2019-01-02 2019-01-02 2019-01-02 23:59:59.999
2  20190103  2019-01-03 2019-01-03 2019-01-03 23:59:59.999
3  20190104  2019-01-04 2019-01-04 2019-01-04 23:59:59.999
4  20190105  2019-01-05 2019-01-05 2019-01-05 23:59:59.999
```

Fig. 3. Represents the Data Model

The process of locating and repairing inaccurate data is known as data cleaning. It might be duplicated, corrupt, inaccurate, incomplete, or irrelevant, or it might be in the wrong format. The data values indicating errors in the data can be fixed in several ways.

For cleaning the data, we handled missing values and formatted columns. We also performed feature engineering like adding date table for connecting various tables.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Date	timeOpen	timeClose	timeHigh	timeLow	quote.open	quote.high	quote.low	quote.close	quote.volume	quote.market	ite.timestamp		
2	0	2023-07-0	2023-07-0	2023-07-0	2023-07-0	0.999819	1.000728	0.999508	1.000129	1.98E+10	8.34E+10	2023-07-01T23:59:59.999Z		
3	1	2023-07-0	2023-07-0	2023-07-0	2023-07-0	1.000108	1.000833	0.999716	1.000085	2.03E+10	8.33E+10	2023-07-02T23:59:59.999Z		
4	2	2023-07-0	2023-07-0	2023-07-0	2023-07-0	1.000049	1.000817	0.999707	0.999998	2.63E+10	8.33E+10	2023-07-03T23:59:59.999Z		
5	3	2023-07-0	2023-07-0	2023-07-0	2023-07-0	0.999945	1.000882	0.999797	1.000301	2.1E+10	8.34E+10	2023-07-04T23:59:59.999Z		
6	4	2023-07-0	2023-07-0	2023-07-0	2023-07-0	1.000391	1.000683	0.999583	1.000094	2.16E+10	8.34E+10	2023-07-05T23:59:59.999Z		
7	5	2023-07-0	2023-07-0	2023-07-0	2023-07-0	1.000009	1.000719	0.99953	1.000206	3.04E+10	8.34E+10	2023-07-06T23:59:59.999Z		
8	6	2023-07-0	2023-07-0	2023-07-0	2023-07-0	1.000039	1.00073	0.999636	0.999959	2.11E+10	8.34E+10	2023-07-07T23:59:59.999Z		
9	7	2023-07-0	2023-07-0	2023-07-0	2023-07-0	1.000129	1.000745	0.99987	1.000187	1.34E+10	8.34E+10	2023-07-08T23:59:59.999Z		

Fig. 4. Represents Uncleaned Data

index	DateId	Open	High	Low	Close	Volume	MarketCap	symbol
1	20190101	6.19	6.19	5.89	6.08	23891162	794641454	BNB
2	20190102	6.09	6.21	5.95	6.19	30308610	809466354	BNB
3	20190103	6.17	6.18	5.90	5.90	22821639	772178241	BNB
4	20190104	5.90	6.07	5.86	6.07	29311136	793315820	BNB
5	20190105	6.06	6.20	6.03	6.07	30340637	793368779	BNB
6	20190106	6.07	6.50	6.03	6.40	41574183	836589632	BNB
7	20190107	6.43	6.43	6.23	6.29	37914513	822912212	BNB

Fig. 5. Represents Cleaned Data

B. *Data Modelling*

Data Modelling is the process of analysing the data objects and their relationship to the other objects. It is employed to examine the data needs necessary for business operations. To storing the data in a database, data models are made. Rather than focusing on the operations that must be carried out, the Data Model primarily addresses what data is required and how it must be organized [7].

In our data model, we have the tables of five different coins, exchanges, and the real-time data. An additional table called “date” has been added for joining these tables.

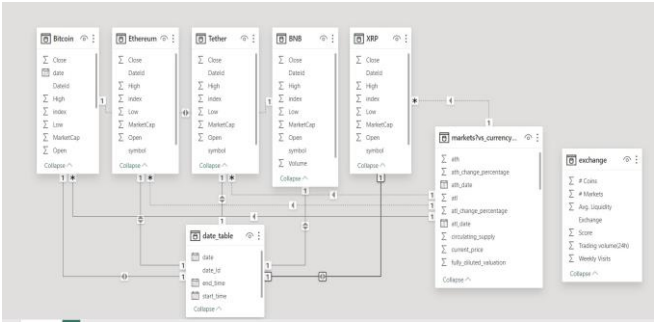

Fig. 6. Represents the Data Model

C. *Data Visualization*

Information and data are represented graphically in data visualization. Data visualization tools offer an easy-to-use means of observing and comprehending trends, outliers, and patterns in data using visual elements such as charts, graphs, and maps. It also offers a great means for staff

members or company owners to clearly communicate data to non-technical audiences [8].

1) *Candlestick Chart*

Each candlestick on the chart represents the price movement within a day. The **body** of the candlestick is the rectangular area which has open and close price. If the close is higher than the open, the body is coloured green, indicating a bullish (upward) movement. If the close is lower than the open, the body coloured red, indicating a bearish (downward) movement. The lines extending above and below the body is called **wick**, the top represents the high and bottom represents the low price.

The below candlestick charts are for the top 5 coins namely, Bitcoin, Ethereum, Tether, BNB, XRP from the years 2019 to 2023.

Fig. 7. Candlestick chart for Bitcoin

Fig. 8. Candlestick chart for Ethereum

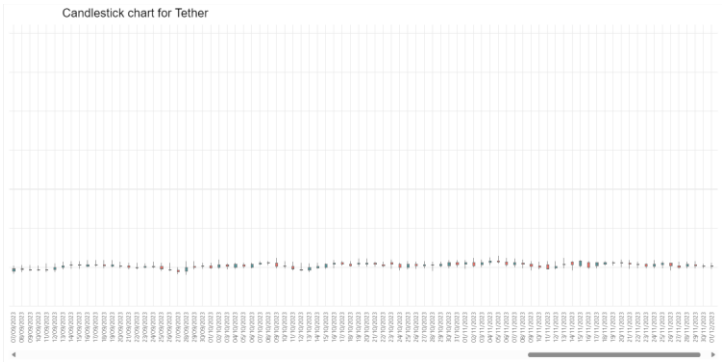

Fig. 7. Candlestick chart for Tether

Fig. 9 Candlestick chart for Binance

Fig. 10. Candlestick chart for Ripple

The above chart for XRP shows a sudden increase in the price on 13 July 2023. This is there was a case filed that a fake filing was designed to look like BlackRock was setting the stage for an XRP -1.73% ETF. The ripple lab won the case. Whenever the case had positive points about the ripple coin (XRP), the price went up.

2) *Open and Close price Analysis using Line chart*

At 00:00:00.000Z (Zulu time), which marks the start of a new trading day, the price at which this initial trade is executed is called the open price. At 23:59:59.999Z (Zulu time), which marks the end of a trading day, the price at which this final trade is executed is called the close price.

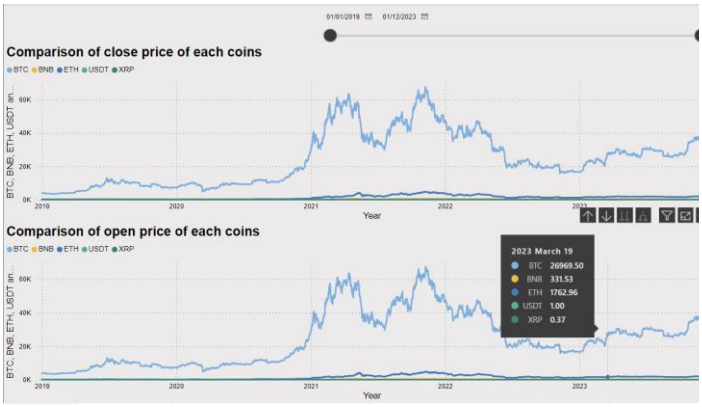

Fig. 11. Comparison of close price of top five coins

The above chart is the comparison of Close price of 5 top coins and the comparison of open price of 5 top coins for over the years from 2019 to 2023 for each day. There is a date slicer to select the range of dates for the comparison.

3) High and Low-price Analysis using Line chart and clustered column chart.

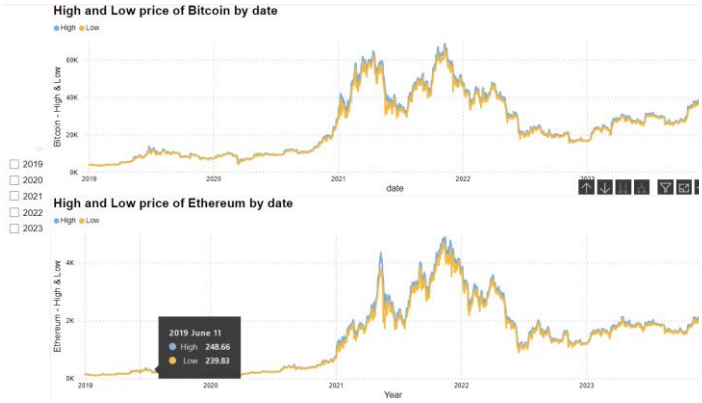

Fig. 12. Comparison of high and low price of Bitcoin

This graph gives an analysis of High and Low price of the coins, bitcoin and Ethereum. The tooltip shows the value for each day of the years from 2019 to 2023. Both the coins have a price increase from 2021.

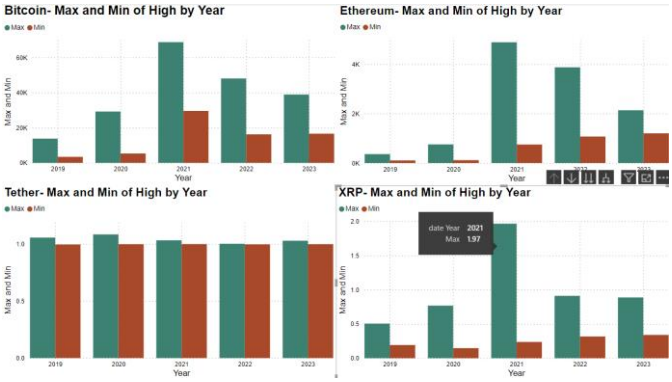

Fig. 13. Analysis of high and low price of Bitcoin and Ethereum

This gives the maximum and maximum values of High price of Bitcoin, Ethereum, Tether and XRP by the year from 2019 to 2023. If we look at Tether, the price does not change much. Tether (USDT) is a type of cryptocurrency known as a stablecoin. Stablecoins are designed to maintain a stable value by pegging their value to a reserve of assets, typically a fiat currency like the US Dollar. Tether is pegged to the US Dollar, and each USDT token is intended to be backed by one US Dollar held in reserve.

4) Volume analysis using line chart

Volume refers to the total number of units of a particular cryptocurrency that are traded during a specific time period usually a day.

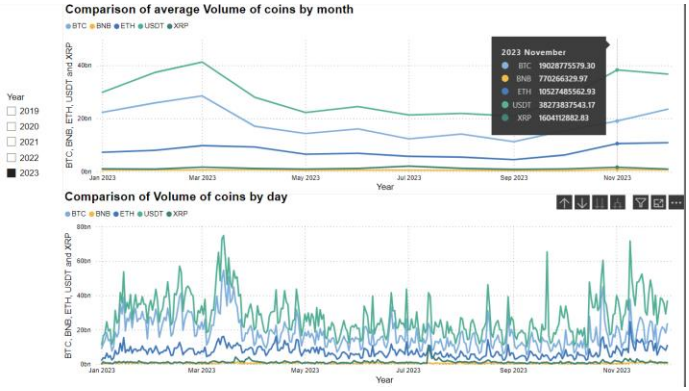

Fig. 14. Comparison of Average Volume of coins by month

This graph shows the comparison of average Volume of each coin by month and comparison of volume of each coin by day. There is date filter by which we can select a particular year for analysis. Tether coin has the highest Volume among the 5 coins in the year 2023.

5) Market cap analysis by donut chart

Market capitalization (market cap) in the context of cryptocurrency refers to the total value of a particular cryptocurrency in circulation. The formula for calculating market capitalization is:

Market Cap = Current Price × Circulating Supply

Current price - price of one unit of the cryptocurrency.

Circulating Supply - The total number of units of the cryptocurrency that are currently available and circulating in the market. It excludes coins that are locked, reserved, or not yet mined.

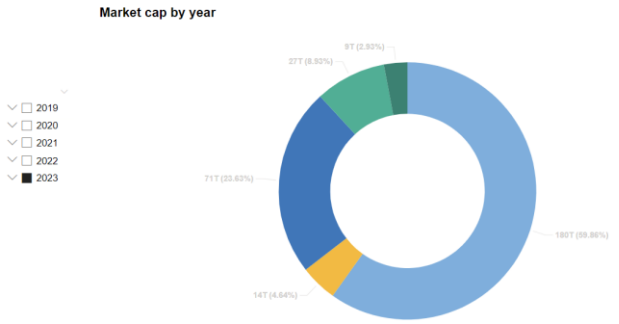

Fig. 15. Market Capitalization by year

This graph shows the market capitalization of top 5 coins with the year filter. This shows that Bitcoin has the high market cap for the year 2023. Ethereum has the second place. XRP has the low market cap among the 5 coins.

Fig. 16. Market Cap by coins

This is the word cloud for the market cap by 100 coins available in the exchange. Depending on upon the value of market cap, the coin word's size is displayed.

6) Exchanges analysis using pie chart and tables

Exchanges serve as trading venues where users can place orders to buy or sell cryptocurrencies. Cryptocurrencies are traded in pairs, where one cryptocurrency is exchanged for another. For example, in the BTC/USD trading pair, Bitcoin is being traded against the US Dollar.

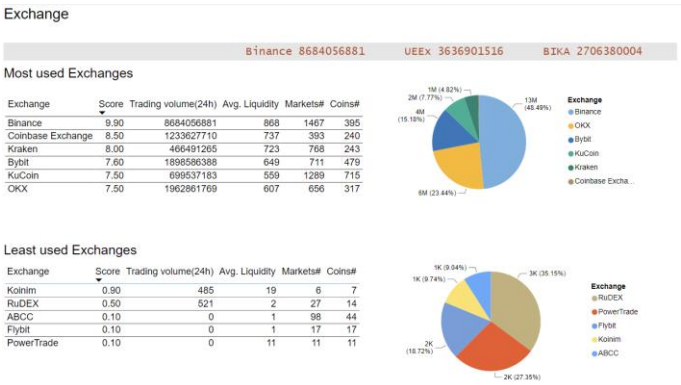

Fig. 17. Illustrates Most and Least used exchanges

Centralized Exchanges (CEX) are traditional exchanges operated by centralized entities. Users create accounts on the platform and trade through the exchange's order book. Examples include Binance, Coinbase, and Kraken.

Decentralized Exchanges (DEX) operates without a central authority. Users retain control of their private keys and trade directly from their wallets. Examples include Uniswap, SushiSwap, and PancakeSwap.

The above graph shows the Score column. By setting a filter for score we can choose mostly used top exchanges and least used exchanges. The pie chart shows the weekly visits for each most used and least used exchanges. It interprets that Binance has most visits about 13 million and it's the topmost used exchange. ABCC ha the least visit of about 1 thousand and it's the least used exchange. The scroller at the top shows the exchange and its trading volume in a marquee text.

7) Current price (Dashboard)

The dashboard has the table of all coins in an exchange ordered by rank. It shows the current price, market cap, volume, 24 hours current price change, circulating supply, high value in 24 hours, low value in 24 hours and price change percentage of 24 hours. The scroller at the top shows the coin and its current price in a marquee text. The name is displayed in green if the coin's current price is increased, in red if the price is decreased. It is calculated by price change percentage of 24 hours.

Bitcoin 1 ▲ 1.3446 Ethereum 2 ▲ 1.884 Tether 3 ▼ -0.1804 BNB 4 ▼ -0.2531

rank	symbol	name	current_price	24h	market_cap	total_volume	circulating_supply	high_24h	low_24h	24
1	btc	Bitcoin	$39,913	$1.8704	$785,095,510,090	14085841608	19,560,231.00	$40,096	$39,309	1
2	eth	Ethereum	$2,198.83	$2.2885	$266,057,755,071	12571084085	120,234,245.27	$2,212.3	$2,151.39	1
3	usdt	Tether	$0.998	$0.167	$89,662,523,261	27764544750	89,596,999,295.47	$1.002	$0.999	-0
4	bnb	BNB	$228.21	$0.1447	$35,255,556,967	638616748	153,856,150.00	$231.62	$226.45	-0
5	xrp	XRP	$0.6232	$1.0619	$33,725,150,031	882675712	53,888,571,585.00	$0.6311	$0.6176	0
6	sol	Solana	$63.38	$1.3804	$27,098,888,685	1336569410	424,333,035.13	$65.38	$62.42	0
7	usdc	USDC	$0.9984	$0.0074	$24,541,046,754	6561255119	24,520,612,960.27	$1.002	$0.998	-0
8	steth	Lido Staked Ether	$2,203.37	$2.6922	$20,572,931,328	12969508	9,293,257.48	$2,214.21	$2,151.32	2
9	ada	Cardano	$0.3954	$0.2082	$13,887,251,531	300375301	34,994,220,267.19	$0.4021	$0.3882	-0
10	doge	Dogecoin	$0.0853	-$0.1824	$12,201,125,572	721578086	142,087,586,383.71	$0.0872	$0.0838	-1
11	trx	TRON	$0.1033	$0.6834	$9,180,204,862	297955744	88,518,731,738.59	$0.1039	$0.1027	0
12	link	Chainlink	$16.04	$0.8224	$8,983,891,806	507117554	556,849,971.23	$16.27	$15.76	0
13	ton	Toncoin	$2.42	-$0.3962	$8,383,506,061	12352739	3,454,153,257.80	$2.45	$2.32	-0
14	avax	Avalanche	$22.05	$0.0482	$8,112,388,838	358550772	365,190,440.95	$22.69	$21.67	-0
15	matic	Polygon	$0.8162	$0.5953	$7,611,116,717	471358482	9,275,188,969.96	$0.822	$0.8006	0
16	dot	Polkadot	$5.57	$0.7484	$7,308,824,957	144785879	1,303,427,207.90	$5.61	$5.44	0
17	wbtc	Wrapped Bitcoin	$39,905	$1.6958	$6,428,414,849	104617415	160,286.37	$40,147	$39,244	1
18	shib	Shiba Inu	$0	$7.4644	$5,398,128,202	392751546	589,326,090,162,920.80	$0	$0	6
19	ltc	Litecoin	$72.19	$0.1802	$5,364,360,626	282414324	73,941,920.73	$72.73	$71.41	-0
20	dai	Dai	$0.9974	$0.3614	$5,347,250,641	354544186	5,349,377,044.54	$1.001	$0.9965	-0
21	uni	Uniswap	$6.08	-$0.1394	$4,622,477,292	294978636	753,766,667.00	$6.25	$5.99	-0
22	bch	Bitcoin Cash	$228.57	$0.9821	$4,497,426,313	128383357	19,575,924.90	$231.83	$225.41	0
23	okb	OKB	$58.38	$0.8176	$3,512,605,825	11386105	60,000,000.00	$59.05	$57.73	0
24	xlm	Stellar	$0.122	$1.0518	$3,432,521,857	51151985	28,039,888,673.12	$0.1228	$0.1208	0
25	leo	LEO Token	$3.64	-$6.7869	$3,389,163,088	2010762	928,348,760.90	$3.92	$3.62	-7

Fig. 18. Shows Coins ordered by rank

Gainers

rank	symbol	name	current_price	24h%	circulating_supply	market_cap	total_
58	lunc	Terra Luna Classic	$0.0002	32.64	5,824,205,796,507.79	$1,136,503,869	7137
38	tao	Bittensor	$348.72	17.62	5,768,416.00	$2,018,666,883	163
97	beam	Beam	$0.0127	11.23	45,344,166,143.14	$578,421,864	449
48	rndr	Render	$3.87	8.61	374,243,312.82	$1,458,302,288	1174
54	snx	Synthetix Network	$3.92	8.28	327,143,751.14	$1,291,882,523	1019

Losers

rank	symbol	name	current_price	24h%	circulating_supply	market_cap	total_
76	mina	Mina Protocol	$0.7385	-2.25	1,012,148,558.84	$753,312,714	22(
55	tia	Celestia	$8.62	-2.45	145,865,445.56	$1,262,182,200	223
95	ape	ApeCoin	$1.6	-2.72	368,593,750.00	$591,622,710	54
99	xrd	Radix	$0.0547	-5.40	10,314,555,698.26	$563,805,706	2
25	leo	LEO Token	$3.64	-7.13	928,348,760.90	$3,389,163,088	2(

Fig. 19. Gainer and Loser coins

The gainer coins and loser coins are calculated by price change percentage of 24 hours. If its consistently increasing, then it is gainer coin, if its consistently decreasing, then it is loser coin. The top 5 gainer coins and loser coins are filtered.

The ATL (All-Time Low) represents the lowest price level that a cryptocurrency has ever reached since it was first listed on exchanges. The ATH (All-Time High) refers to the highest price level that a cryptocurrency has achieved since its inception.

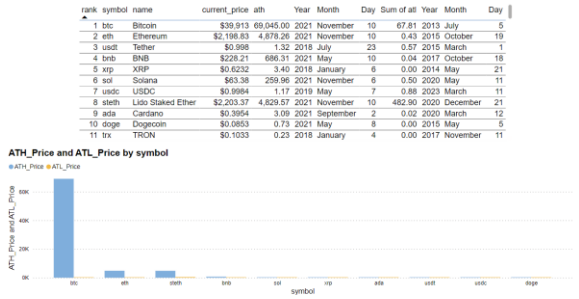

Fig. 20. ATH and ATL Prices

The above graph shows the ATH and ATL price for few top coins using the clustered column graph. This is often considered a crucial indicator for assessing the historical performance and price potential of a cryptocurrency. Traders and investors may look at ATH values to understand the peak value of an asset and assess its current price in relation to its historical high.

D. Deep Analysis - Predictive Modelling

We started our deep analysis by splitting our data into test and training sets. We explored supervised machine learning methods using pandas, sklearn, and matplotlib in a Jupyter notebook.

1) Linear Regression Model

To measure the Root Mean Squared Error (RMSE) for our datasets, we first used Linear Regression. This method unexpectedly revealed an error rate of between 92 and 93% for both the test and training datasets, pointing to a sizable discrepancy between expected and actual values. This disparity suggested that our complicated dataset might not be the best fit for linear regression.

```
rmse on train set is 92.54769734162778
rmse on test set is 93.09064853518845
```

Fig. 21. RMSE for Linear Regression Model

2) Logistic Regression Model

We looked to Logistic Regression and the well-known Random Forest model to investigate more complex models and improve predictive performance. But the accuracy rate of the Logistic Regression model was 0%, indicating that it was not appropriate for our dataset.

```
Accuracy of Logistic Regression model on the train set: 0.00
Accuracy of the Logictic Regression model on the test set: 0.00

array([[0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       ...,
       [0, 0, 0, ..., 0, 1, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 1, 0]], dtype=int64)
```

Fig. 22. RMSE for Logistic Regression Model

3) Random Forest Model

We investigated the popular classification model known as the Random Forest Model. It showed a 20% approximation to accuracy, which was not very impressive but was still better than Linear Regression.

```
Accuracy of Random Forest model on the train set: 0.19
Accuracy of Random Forest model on the test set: 0.00

array([[0, 0, 1, ..., 0, 0, 0],
       [0, 0, 1, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       ...,
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 1, 0]], dtype=int64)
```

Fig. 23. Accuracy for Random Forest Model

4) Support Vector Regression Model

A popular technique for regression analysis is Support Vector Regression (SVR), which is a subset of Support Vector Machine (SVM) algorithms. Classification problems are the main application for SVMs, which are strong supervised learning algorithms [9].

This model provided an accuracy of 70% which was significantly higher than the other three models.

```
svr_rbf_confidence =svr_rbf.score(x_test, y_te
print('svr_rbf accuracy:', svr_rbf_confidence)

svr_rbf accuracy: 0.7032362955152913
```

Fig. 24. Accuracy for Support Vector Regression Model

E. Forecasting Future Price Movements using Statistical Technical Indicators

Simple Moving Average (SMA): SMA is a commonly used technical indicator that calculates the average price of a cryptocurrency over a specified number of periods. It provides a smoothed trend line that helps identify the general direction of the price movement.

The crossover of short-term and long-term SMAs can signal potential trend reversals.

A "Golden Cross" occurs when a short-term SMA crosses above a long-term SMA, suggesting a bullish trend. Conversely, a "Death Cross" occurs when the short-term SMA crosses below the long-term SMA, signalling a potential bearish trend.

Pros: Simple and easy to understand. Useful for identifying trends over longer time frames.

Cons: Can be slow to react to recent price changes. Prone to false signals during choppy or sideways markets.

Fig. 25. Simple Moving Average

```
1 SMA_10Days =
2 AVERAGEX(
3     DATESBETWEEN(Bitcoin[date], MAX(Bitcoin[date]) - 9, MAX(Bitcoin[date])),
4     CALCULATE(SUM(Bitcoin[Close]))
5 )
1 SMA_25Days =
2 AVERAGEX(
3     DATESBETWEEN(Bitcoin[date], MAX(Bitcoin[date]) - 24, MAX(Bitcoin[date])),
4     CALCULATE(SUM(Bitcoin[Close]))
5 )
1 SMA_50Days =
2 AVERAGEX(
3     DATESBETWEEN(Bitcoin[date], MAX(Bitcoin[date]) - 49, MAX(Bitcoin[date])),
4     CALCULATE(SUM(Bitcoin[Close]))
```

Fig. 26. DAX Queries for SMA of three distinct intervals

These calculations are based on the closing prices provided and the respective number of days for each SMA. The resulting values represent the Simple Moving Averages for the specified periods (10 days, 25 days, and 50 days).

SMA provides a straightforward average of prices over a specified period. It smoothens out price fluctuations, making it useful for identifying trends and general market direction.

A Death Cross occurs when the short-term SMA (10 days) crosses below the long-term SMA (50 days), the price of the coin goes considerably down. Thus, the price for future can be analysed and predicted.

Exponential Moving Average (EMA):

MA is a more complex moving average that gives greater weight to more recent prices. It reacts more quickly to price changes compared to the SMA, making it more responsive to short-term price movements. It places more emphasis on recent prices, making it more responsive to sudden market shifts.

Like SMA, crossovers between short-term and long-term EMAs can provide signals for trend reversals. EMA reacts more promptly to changes, potentially reducing lag.

Pros: More responsive to recent price changes. Useful for short-term trend analysis. Reduces lag compared to SMA.

Cons: Can be more sensitive to market noise.

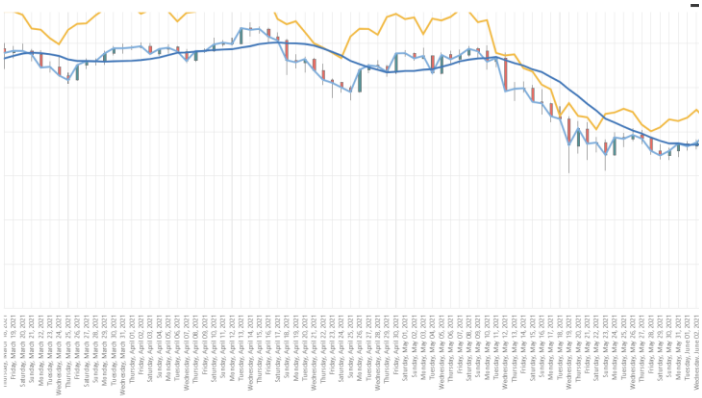

Fig. 27. Exponential Moving Average

```
EMA_10Days =
VAR Alpha = 2 / (10 + 1)
RETURN
CALCULATE(
    SUMX(
        ADDMISSINGITEMS(
            VALUES('Bitcoin'[Date]),
            'Bitcoin'[Date]
        ),
        'Bitcoin'[Close] * (1 - Alpha)
    ) +
    MAX('Bitcoin'[Close]) * Alpha,
    ALLEXCEPT('Bitcoin', 'Bitcoin'[Date])
)
```

Fig. 28. DAX query for Exponential Moving Average

IV. Conclusion

The visualizations presented illustrate the historical growth of cryptocurrencies over the years. Our prediction models have provided a notable accuracy in forecasting the current market trends. Cryptocurrency is a highly volatile market, and it is difficult to predict future price movements. However, there are many statistical techniques that provide an underlying pattern for traders to make decisions. SMA and EMA can provide valuable insights into short-term and long-term price trends, they are not foolproof predictors of future cryptocurrency prices. Our study is purely intended to provide information and educational purposes. It should not be perceived as absolute guarantees. Investors should conduct thorough research and be mindful of the inherent risks before investing in cryptocurrencies.

REFERENCES

[1] Kaspersky, "What is cryptocurrency and how does it work?" *Kaspersky*, 2022. https://www.kaspersky.com/resource-center/definitions/what-is-cryptocurrency

[2] How does blockchain work? | stanford online, https://online.stanford.edu/how-does-blockchain-work (accessed Dec. 8, 2023).

[3] "How Does Cryptocurrency Work? A Beginner Guide," Coursera. https://www.coursera.org/articles/how-does-cryptocurrency-work

[4] "How to Create a Cryptocurrency for Your Business," Jelvix. https://jelvix.com/blog/how-to-create-a-cryptocurrency-for-your-business

[5] R. Maheshwari, "What Are Crypto Exchanges And How Do They Work," Forbes Advisor INDIA, Jun. 30, 2023. https://www.forbes.com/advisor/in/investing/cryptocurrency/what-is-a-crypto-exchange/

[6] Coinbase, "Crypto basics - What is a crypto wallet?," www.coinbase.com. https://www.coinbase.com/learn/crypto-basics/what-is-a-crypto-wallet

[7] "Data Modelling - Understanding Tools and Techniques Involved," www.xenonstack.com. https://www.xenonstack.com/insights/data-modelling

[8] Tableau, "Data visualization beginner's guide: a definition, examples, and learning resources," Tableau Software, 2018. https://www.tableau.com/learn/articles/data-visualization

[9] N. Rasifaghihi, "Support Vector Regressor — Theory and Coding Exercise in Python," Medium, May 15, 2023. https://medium.com/@niousha.rf/support-vector-regressor-theory-and-coding-exercise-in-python-ca6a7dfda927