Optimizing Cryptocurrency Token Selection Through Conflict Resolution Using a Graph-Theoretic Approach

Geraldo Artemius - 13524005
Program Studi Teknik Informatika
Sekolah Teknik Elektro dan Informatika
Institut Teknologi Bandung, Jalan Ganesha 10 Bandung
E-mail: [1]geraldoartemius2005@gmail.com, [2]13524005@std.stei.itb.ac.id

***Abstract*—Due to cryptocurrency's volatility, Investors and traders often face challenges in selecting the right tokens due to conflicting price movements across ecosystems and the significant influence of Bitcoin Dominance. This paper proposes an approach to optimize token selection using graph theory, specifically the Welsh-Powell graph colouring algorithm. By modeling cryptocurrency ecosystems as graph nodes and assigning edges to represent conflicts or negative correlations, the result identifies incompatible token pairs that should not be held simultaneously. Bitcoin Dominance is treated as a central node connected to all ecosystems due to its widespread impact. Through this graph-based model, investors can construct conflict-free portfolios, adjust strategies based on prevailing seasonal trends, and maximize returns while mitigating risk.**

***Keywords*—Graph colouring, Cryptocurrency, Bitcoin Dominance, Welsh-Powell Algorithm, Token Ecosystems.**

I. Introduction

In recent years, virtual currencies known as cryptocurrencies have become one of the most prominent financial instruments in the global economy due to the convenience and benefits they offer. The global cryptocurrency market represents one of the most volatile and complex financial ecosystems in the world, with a large number of tokens and ecosystems. Multiple factors drive this complexity, including macroeconomic trends, technological advancement, worldwide events, and particularly the dominance of Bitcoin. Bitcoin dominance is inversely related to altcoins, when the bitcoin dominance's price increases, many altcoins tend to decline in value. These dynamic market conditions are causing investors and traders to constantly monitor and adjust their portfolios in response to rapidly changing market shifts.

Adding to this complexity are the various token ecosystems within the cryptocurrency space, including Decentralized Finance (DeFi), GameFi, Artificial Intelligence (AI), Real World Assets (RWAs), Infrastructure projects Layer1/Layer2 (L1/L2), and so much more. These ecosystems often follow seasonal cycles, where one ecosystem might rapidly increase in prices while others are experiencing downturns. For instance, during a bull market for AI tokens, meme or gaming tokens might experience a decrease in their price due to capital shifts. This complexity makes it challenging for investors and traders to navigate these complex factors to optimize their portfolio timing and allocation decisions across multiple ecosystems simultaneously.

Moreover, with the global cryptocurrency users exceeding 560 million, the diversity in investor behavior and token utility complicates portfolio decision-making. Investors and traders are no longer choosing tokens based on performance, but also on their relevance to emerging technologies, popularity among online communities, and strategic position within major blockchain ecosystems.

Investors and traders seek to build a diversified portfolio to face the challenge of selecting tokens that not only perform well individually during a specific market season, but also maintain minimal negative correlations with other tokens. To solve this issue, this paper proposes a graph theoretic solution, specifically the Welsh-Powell graph colouring algorithm to resolve conflicts and optimize token selection based on ecosystem behavior during a specific season and the current bitcoin dominance trend. By modeling tokens or ecosystems as nodes and conflicts, such as negative correlations or seasonal opposition, Bitcoin dominance is modeled as a central node affecting all tokens This paper aims to help investors and traders maximize portfolio performance in achieving enhanced profit.

II. Theoretical Framework

A. Graph Theory Fundamentals

Graph theory is a branch of mathematics that studies relationship between objects. A graph $G = (V,E)$ where V is a non-empty set of vertices (or nodes) and E is a set of edges (or links) connecting pairs of vertices.

Graph can be divided into two :

- Simple Graph : A type of graph that doesn't have multiple edges (more than one edge between any pair of vertices) or loops (edges that connect a vertex to itself)
- Unsimple Graph : A type of graph that allows multiple edges (parallel edges) between the same pair or vertices and may also include loops.

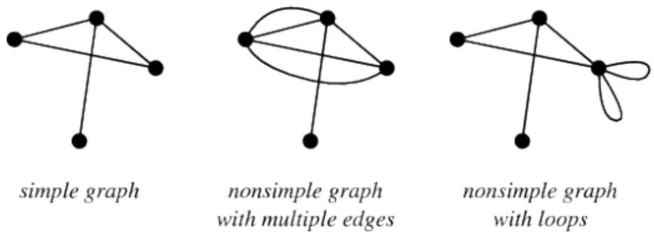


Fig 2.1.1 *Simple and Non-Simple Graph*
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

Unsimple-graph can be divided into two :

- Multi-graph : Graph with parallel edges.
- Pseudo-graph : Graph contains a self-loop.

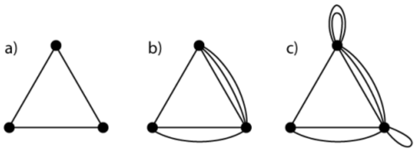


Fig 2.1.2 *a) Simple Graph b) Multi-graph c) Pseudo-graph*
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

Graph can also be categorized based on the orientation of their edges :

- Undirected Graph : Edges have no direction. The order of the vertices in an edge doesn't matter.
- Directed Graph : Edges have a specific direction, meaning that each edge goes from one vertex to another vertex. The direction is often represented by an arrow, indicating one-way relationships.

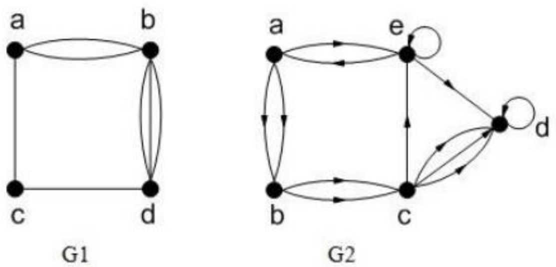


Fig 2.1.3 *Undirected Graph (G1) and Directed Graph (G2)*
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

Terminologies in graphs that need to be considered in this paper :

1. **Adjacent Vertices** : In a graph $G = (V,E)$ two vertices are said to be adjacent (neighbor) if there exists an edge between two vertices. In Fig 2.1.4 Node 1 is adjacent with node 2 and node 3, but aren't adjacent to node 4.

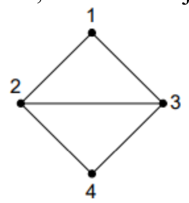


Fig 2.1.4 *Undirected Graph with four nodes*
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

2. **Incidency** : For any edge $e = (v_j,v_k)$, it is said that e is incident to vertex v_j and vertex v_k. In Fig 2.1.5 edge e_1 is incident to vertex 1 and vertex 2.

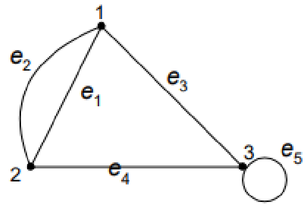


Fig 2.1.5 *Graph with 5 edges*
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

3. **Isolated Vertex** : A node that has no edges side by side with him. In Fig 2.1.6 node 5 is the isolated vertex.

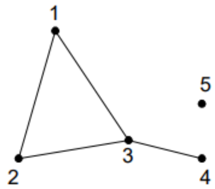


Fig 2.1.6 *Graph with 5 nodes*
Source : https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf

4. **Degree** : Number of edges that are incident to the vertex, notation $d(v)$ represents the degree of a vertex. If a vertex contains a loop then it counts as two. This creates a theory named *Handshaking Lemma*, it states that in any undirected graph, the sum of the degrees of all vertices is equal to twice the number of edges in the graph. If $G = (V,E)$, then $\sum_{v=V} d(v) = 2|E|$. On Fig 2.1.4 d(1) = 3 and d(3) = 4.

B. Graph Colouring

Graph colouring problem involves assigning colour to certain elements of a graph subject to certain restrictions and constraints. In other words, the process of assigning colours to the vertices such that no two adjacent vertexes have the same colour (vertex colouring).

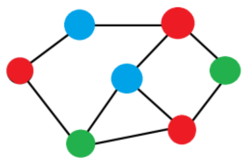


Fig 2.2.1 *Example of Graph Colouring*

Source : https://www.naukri.com/code360/library/graph-coloring

Chromatic Number χ(G) : The smallest number of colours needed to colour a graph *G*. For example, In Fig 2.2.1 the vertices can be coloured using a minimum of three colours. Hence the chromatic number of the graph is three (χ(G) = 3).

C. Welsh-Powell Algorithm

The Welsh-Powell algorithm is a greedy algorithm used for graph colouring, which aims to assign colours to the vertices of a graph such that no two adjacent vertices share the same colour.

Here are the steps :

Step 1. Calculate the degree of each vertex in the graph

Step 2. Sort the vertices in descending order of degree (from highest to lowest).

Step 3. Colour the first vertex in the ordered list with the first colour.

Step 4. Move to the next vertex in the order. Colour this vertex with the same colour if it is not adjacent to any previously coloured vertex with that colour.

Step 5. Repeat step 4 for all uncoloured vertices using a new colour, starting from the vertex with the next highest degree in the descending order.

Key : Always try to reuse existing colours before introducing new ones.

D. Cryptocurrency

Cryptocurrency is a form of currency that exists digitally or virtually and uses cryptography to secure transactions. Cryptocurrencies use a decentralized system to record transactions and issue new units, it doesn't rely on banks to verify transactions. Cryptocurrency received its name because it uses encryption to verify transactions. The first cryptocurrency was Bitcoin, which was founded in 2009 and remains the best known today.

Cryptocurrency market volatility often exceed 10%-20% daily, or even hundreds of percent during periods of hype or panic. Bitcoin dominance refers to Bitcoin's share of the total cryptocurrency market capitalization and typically ranges from 40% to 70%. It acts as a macro-level indicator reflecting where capital is flowing in the crypto ecosystem. A rising Bitcoin dominance usually signals a shift toward safer assets during market uncertainty. Conversely, when Bitcoin dominance falls, it often marks an "altcoin season".

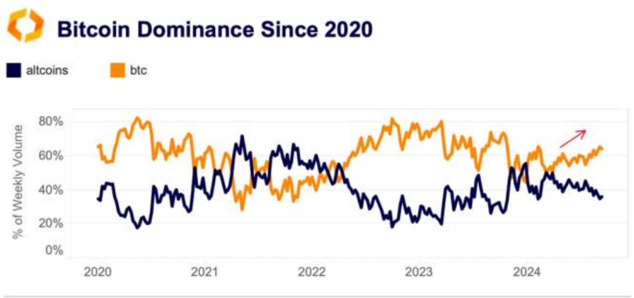


Fig 2.4.1 *Chart of Bitcoin dominance vs Altcoin index (inverse relationship)*
Source : https://research.kaiko.com/insights/bitcoins-dominance-over-altcoins

E. Cryptocurrency Ecosystems – Functional Categories

A cryptocurrency ecosystem refers to a network of related digital assets, technologies, platforms, and communities built around a particular blockchain. Cryptocurrency ecosystems can be grouped based on their use cases, core technology, or market narratives. These categories often move in cycles (seasons) and react differently to market trends, which is crucial for timing investments and managing risk.

- **DeFi** (Decentralized Finance) :
  Focuses on financial applications such as lending, borrowing, yield farming, and decentralized exchanges. The projects is Aave, Compound, and. Performs well in bull markets driven by innovation.
- **GameFi** (Gaming + Finance) :
  Combines gaming with financial incentives, allowing users to earn tokens through gameplay. Popular examples include Axie Infinity and Illuvinum. Often leads to altcoin seasons but also crashes hard during downtrends.
- **AI** (Artificial Intelligence) :
  This ecosystem represents projects that aim to decentralize AI models and computation, and often experience strong upward price action during global AI hype cycles. Render (RNDR), Fetch.ai (FET), and SingularityNET (AGIX) are the tokens.
- **Layer 1/2 Infrastructure** :
  Layer 1 platforms like Ethereum, Solana, and BNB Chain offer base-level smart contract execution, while Layer 2 solutions such as Arbitrum and Optimism enhance scalability and reduce transaction costs. These form the "backbone" of crypto.
- **RWA (Real World Assets)** :
  This ecosystem represents a newer class of assets that aim to bridge traditional finance and blockchain. Tokenized physical assets such as gold, real estate, and bonds and the usage of this ecosystem.

III. DATA PREPARATION

A. Closing Price Across Quartiles

To determine the correlation between cryptocurrency ecosystems, representative tokens from each ecosystem are selected and their returns are collected and averaged to generate ecosystem-level return metrics.

The writer uses the year 2023 to collect the token prices from every quartile during a specific season.

Quartile 1 : AI Season

AI	January		February		March	
	15	30	15	28	15	30
RNDR	$0.543	$1.23	$1.83	$1.56	$1.32	$1.24
AGIX	$0.16	$0.17	$0.424	$0.47	$0.447	$0.411
FET	$0.235	$0.27	$0.446	$0.448	$0.409	$0.365

Table 3.1.1 *AI Ecosystem Price Q1*

GameFi	January		February		March	
	15	30	15	28	15	30
AXS	$9.11	$11.24	$10.15	$9.93	$7.92	$8.24
GALA	$0.048	$0.055	$0.045	$0.040	$0.040	$0.040
SAND	$0.665	$0.74	$0.715	$0.707	$0.60	$0.618

Table 3.1.2 *GameFi Ecosystem Price Q1*

DeFi	January		February		March	
	15	30	15	28	15	30
AAVE	$80.98	$82.61	$83.50	$78.96	$75.80	$72.23
UNI	$6.63	$6.64	$6.61	$6.60	$5.96	$5.96
COMP	$52.74	$53.41	$50.41	$49.82	$43.82	$42.36

Table 3.1.3 *DeFi Ecosystem Price Q1*

L1/L2	January		February		March	
	15	30	15	28	15	30
SOL	$23.67	$24.41	$22.43	$22.53	$19.41	$20.54
OP	$1.86	$2.17	$2.53	$2.80	$2.58	$2.20
AVAX	$17.00	$20.39	$18.48	$17.53	$16.07	$17.3

Table 3.1.4 *Layer1/Layer2 Ecosystem Price Q1*

RWA	January		February		March	
	15	30	15	28	15	30
GFI	$0.51	$0.62	$0.61	$0.68	$0.66	$0.59
CFG	$0.236	$0.276	$0.24	$0.29	$0.35	$0.28
TRU	$0.03	$0.04	$0.04	$0.09	$0.1	$0.077

Table 3.1.5 *RWA Ecosystem Price Q1*

Quartile 2 : DeFi + Infrastructure Season

AI	April		May		June	
	15	30	15	30	15	30
RNDR	$1.71	$2.53	$1.83	$2.6	$1.76	$1.96
AGIX	$0.446	$0.34	$0.264	$0.31	$0.19	$0.22
FET	$0.42	$0.34	$0.247	$0.275	$0.177	$0.215

Table 3.1.6 *AI Ecosystem Price Q2*

GameFi	April		May		June	
	15	30	15	30	15	30
AXS	$9.09	$8.02	$6.87	$7.03	$4.69	$5.71
GALA	$0.04	$0.04	$0.03	$0.029	$0.02	$0.024
SAND	$0.69	$0.59	$0.51	$0.55	$0.37	$0.40

Table 3.1.7 *GameFi Ecosystem Price Q2*

DeFi	April		May		June	
	15	30	15	30	15	30
AAVE	$83.72	$71.9	$63.76	$66.57	$49.48	$65.34
UNI	$6.32	$5.61	$5.16	$5.14	$4.28	$5.00
COMP	$45.36	$42.3	$35.27	$36.51	$26.35	$54.0

Table 3.1.8 *DeFi Ecosystem Price Q2*

L1/L2	April		May		June	
	15	30	15	30	15	30
SOL	$24.42	$23.77	$21.4	$21	$14.48	$18.16
OP	$2.76	$2.22	$1.68	$1.48	$1.08	$1.28
AVAX	$19.27	$17.7	$15.3	$14.46	$11.2	$12.62

Table 3.1.9 *Layer1/Layer2 Ecosystem Price Q2*

RWA	April		May		June	
	15	30	15	30	15	30
GFI	$0.66	$0.57	$0.438	$0.405	$0.296	$0.335
CFG	$0.273	$0.255	$0.206	$0.218	$0.17	$0.265
TRU	$0.077	$0.06	$0.047	$0.04	$0.032	$0.040

Table 3.1.10 *RWA Ecosystem Price Q2*

Quartile 3 : Bitcoin Dominance

AI	July		August		September	
	15	30	15	30	15	30
RNDR	$2.02	$1.80	$1.68	$1.43	$1.58	$1.53
AGIX	$0.25	$0.22	$0.213	$0.182	$0.18	$0.185
FET	$0.24	$0.21	$0.21	$0.216	$0.23	$0.22

Table 3.1.11 *AI Ecosystem Price Q3*

GameFi	July		August		September	
	15	30	15	30	15	30
AXS	$6.37	$6.17	$5.77	$4.88	$4.72	$4.58
GALA	$0.025	$0.023	$0.022	$0.02	$0.014	$0.014
SAND	$0.453	$0.435	$0.386	$0.322	$0.3	$0.31

Table 3.1.12 *GameFi Ecosystem Price Q3*

DeFi	July		August		September	
	15	30	15	30	15	30
AAVE	$78.83	$74.2	$65.0	$58.0	$54.46	$68.43
UNI	$5.86	$6.4	$6.24	$4.66	$4.29	$4.46
COMP	$74.9	$72.5	$54.5	$42.5	$40.6	$46.9

Table 3.1.13 *DeFi Ecosystem Price Q3*

L1/L2	July		August		September	
	15	30	15	30	15	30
SOL	$28.0	$24.9	$24.77	$20.8	$18.88	$21.42
OP	$1.47	$1.59	$1.51	$1.50	$1.40	$1.34
AVAX	$15.12	$13.3	$12.25	$10.4	$9.25	$9.25

Table 3.1.14 *Layer1/Layer2 Ecosystem Price Q3*

RWA	July		August		September	
	15	30	15	30	15	30
GFI	$0.433	$0.448	$0.385	$0.33	$0.40	$0.45
CFG	$0.35	$0.29	$0.281	$0.22	$0.24	$0.31
TRU	$0.04	$0.035	$0.037	$0.030	$0.035	$0.037

Table 3.1.15 *RWA Ecosystem Price Q3*

Quartile 4 : GameFi + Infrastructure L1/L2

AI	October		November		December	
	15	30	15	30	15	30
RNDR	$1.73	$2.55	$2.64	$3.39	$4.59	$4.74
AGIX	$0.165	$0.237	$0.25	$0.30	$0.342	$0.327
FET	$0.211	$0.373	$0.42	$0.522	$0.70	$0.69

Table 3.1.16 *AI Ecosystem Price Q4*

GameFi	October		November		December	
	15	30	15	30	15	30
AXS	$4.28	$5.79	$6.35	$6.32	$7.14	$9.06
GALA	$0.013	$0.02	$0.023	$0.025	$0.03	$0.03
SAND	$0.288	$0.355	$0.43	$0.40	$0.50	$0.58

Table 3.1.17 *GameFi Ecosystem Price Q4*

DeFi	October		November		December	
	15	30	15	30	15	30
AAVE	$63.95	$83.0	$94.45	$96.5	$110.7	$112.4
UNI	$4.1	$4.19	$5.33	$5.9	$6.14	$7.5
COMP	$40.72	$46.94	$58.7	$50.7	$52.6	$59.5

Table 3.1.18 *DeFi Ecosystem Price Q4*

L1/L2	October		November		December	
	15	30	15	30	15	30
SOL	$21.75	$35.0	$62.4	$59.3	$76.0	$103.8
OP	$1.19	$1.41	$1.86	$1.65	$2.13	$3.72
AVAX	$9.13	$11.56	$20.3	$21.0	$40.4	$39.8

Table 3.1.19 *Layer1/Layer2 Ecosystem Price Q4*

RWA	October		November		December	
	15	30	15	30	15	30
GFI	$0.344	$0.40	$0.578	$1.40	$1.38	$1.21
CFG	$0.30	$0.413	$0.544	$0.66	$0.629	$0.657
TRU	$0.034	$0.038	$0.046	$0.055	$0.050	$0.056

Table 3.1.20 *RWA Ecosystem Price Q4*

B. Average Return per Ecosystem

$$Result_t = \frac{Price_t - Price_{t-1}}{Price_{t-1}}$$

Quartile 1

AI Ecosystem :

- RNDR :

$$Result_{t=Jan\,30} = \frac{(1.23 - 0.543)}{0.543} = 1.265 = 126.5\%$$

$$Result_{t=Feb\,15} = \frac{(1.83 - 1.23)}{1.23} = 0.487 = 48.7\%$$

$$Result_{t=Feb\ 28} = \frac{(1.56 - 1.83)}{1.83} = -0.147 = -14.7\%$$
$$Result_{t=Mar\ 15} = \frac{(1.32 - 1.56)}{1.56} = -0.153 = -15.4\%$$
$$Result_{t=Mar\ 30} = \frac{(1.24 - 1.32)}{1.32} = -0.06 = -6\%$$

Average Return RNDR :

$$\frac{126.5 + 48.7 + (-14.7) + (-15.4) + (-6)}{5} = 27.82\%$$

Now, we just repeat the same process until we get all of the average returns of every token that represents their ecosystem.

- AGIX :

$$\frac{(0.17 - 0.16)}{0.16} + \frac{(0.424 - 0.17)}{0.17} + \frac{(0.47 - 0.424)}{0.424} = 1.66 = 166\%$$
$$\frac{(0.447 - 0.47)}{0.47} + \frac{(0.411 - 0.447)}{0.447} = -0.129 = -12.9\%$$

Average Return AGIX :

$$\frac{(166 - 12.9)}{5} = 30.62\%$$

- FET
Average Return FET : 12.21%

Average Return AI Ecosystem :

$$\frac{27.82\% + 30.62\% + 12.21\%}{3} = 23.55\%$$

GameFi Ecosystem :

TOKENS	AXS	GALA	SAND
Average Return	-0.93%	-2.9%	-1%

***Table 3.2.1** GameFi Ecosystem Average Return Q1*

Average Return GameFi Ecosystem :

$$\frac{-0.93\% + (-2.9\%) + (-1\%)}{3} = -1.61\%$$

DeFi Ecosystem :

TOKENS	AAVE	UNI	COMP
Average Return	-2.2%	-2%	-4%

***Table 3.2.2** DeFi Ecosystem Average Return Q1*

Average Return DeFi Ecosystem :

$$\frac{-2.2\% + (-2\%) + (-4\%)}{3} = -2.73\%$$

L1/L2 Ecosystem :

TOKENS	SOL	OP	AVAX
Average Return	-2.5%	4.2%	0.9%

***Table 3.2.3** Layer1/Layer2 Ecosystem Average Return Q1*

Average Return L1/L2 Ecosystem :

$$\frac{-2.5\% + (4.2\%) + (0.9\%)}{3} = 0.87\%$$

RWA Ecosystem :

TOKENS	GFI	CFG	TRU
Average Return	3.5%	5%	29%

***Table 3.2.4** RWA Ecosystem Average Return Q1*

Average Return L1/L2 Ecosystem :

$$\frac{3.5\% + 5\% + 29\%}{3} = 12.5\%$$

Quartile 2

AI Ecosystem :

TOKENS	RNDR	AGIX	FET
Average Return	8.2%	-10.3%	-9.8%

***Table 3.2.5** AI Ecosystem Average Return Q2*

Average Return AI Ecosystem :

$$\frac{8.2\% + (-10.3\%) + (-9.8\%)}{3} = -3.97\%$$

GameFi Ecosystem :

TOKENS	AXS	GALA	SAND
Average Return	-7%	-7.8%	-9%

***Table 3.2.6** GameFi Ecosystem Average Return Q2*

Average Return GameFi Ecosystem :

$$\frac{-7\% + (-7.8\%) + (-9\%)}{3} = -7.93\%$$

DeFi Ecosystem :

TOKENS	AAVE	UNI	COMP
Average Return	-2.53%	-3.5%	11.06%

***Table 3.2.7** DeFi Ecosystem Average Return Q2*

Average Return DeFi Ecosystem :

$$\frac{-2.53\% + (-3.5\%) + 11.06\%}{3} = 1.68\%$$

L1/L2 Ecosystem :

TOKENS	SOL	OP	AVAX
Average Return	-4.83%	-12.86%	-7.81%

***Table 3.2.8** Layer1/Layer2 Ecosystem Average Return Q2*

Average Return L1/L2 Ecosystem :

$$\frac{-4.83\% + (-12.86\%) + (-7.81\%)}{3} = -8.5\%$$

RWA Ecosystem :

TOKENS	GFI	CFG	TRU
Average Return	-11.21%	2.78%	-10.33%

Table 3.2.9 *RWA Ecosystem Average Return Q2*

Average Return RWA Ecosystem :

$$\frac{-11.21\% + 2.78\% + (-10.22\%)}{3} = -6.25\%$$

Quartile 3

AI Ecosystem :

TOKENS	RNDR	AGIX	FET
Average Return	-5.82%	-5.61%	-1.1%

Table 3.2.10 *AI Ecosystem Average Return Q3*

Average Return AI Ecosystem :

$$\frac{-5.82\% + (-5.61\%) + (-1.1\%)}{3} = -4.18\%$$

GameFi Ecosystem :

TOKENS	AXS	GALA	SAND
Average Return	-6.26%	-10.69%	-7.86%

Table 3.2.11 *GameFi Ecosystem Average Return Q3*

Average Return GameFi Ecosystem :

$$\frac{-6.26\% + (-10.69\%) + (-7.86\%)}{3} = -8.27\%$$

DeFi Ecosystem :

TOKENS	AAVE	UNI	COMP
Average Return	-1.51%	-4.52%	-7.8%

Table 3.2.12 *DeFi Ecosystem Average Return Q3*

Average Return DeFi Ecosystem :

$$\frac{-1.51\% + (-4.52\%) + (-7.8\%)}{3} = -4.61\%$$

L1/L2 Ecosystem :

TOKENS	SOL	OP	AVAX
Average Return	-4.67%	-1.7%	-9.62%

Table 3.2.13 *Layer1/Layer2 Ecosystem Average Return Q3*

Average Return L1/L2 Ecosystem :

$$\frac{-4.67\% + (-1.7\%) + (-9.62\%)}{3} = -5.33\%$$

RWA Ecosystem :

TOKENS	GFI	CFG	TRU
Average Return	1.77%	-0.07%	-0.27%

Table 3.2.14 *RWA Ecosystem Average Return Q3*

Average Return RWA Ecosystem :

$$\frac{1.77\% + (-0.07\%) + (-0.27\%)}{3} = -0.48\%$$

Quartile 4

AI Ecosystem :

TOKENS	RNDR	AGIX	FET
Average Return	23.20%	15.75%	29.27%

Table 3.2.15 *AI Ecosystem Average Return Q4*

Average Return AI Ecosystem :

$$\frac{23.20\% + 15.75\% + 29.27\%}{3} = 22.74\%$$

GameFi Ecosystem :

TOKENS	AXS	GALA	SAND
Average Return	16.47%	19.51%	15.68%

Table 3.2.16 *GameFi Ecosystem Average Return Q4*

Average Return GameFi Ecosystem :

$$\frac{16.47\% + 19.51\% + 15.68\%}{3} = 17.22\%$$

DeFi Ecosystem :

TOKENS	AAVE	UNI	COMP
Average Return	12.83%	13.64%	8.52%

Table 3.2.17 *DeFi Ecosystem Average Return Q4*

Average Return DeFi Ecosystem :

$$\frac{12.83\% + 13.64\% + 8.52\%}{3} = 11.66\%$$

L1/L2 Ecosystem :

TOKENS	SOL	OP	AVAX
Average Return	39.40%	28.17%	39.70%

Table 3.2.18 *Layer1/Layer2 Ecosystem Average Return Q4*

Average Return L1/L2 Ecosystem :

$$\frac{39.40\% + 28.17\% + 39.70\%}{3} = 35.76\%$$

RWA Ecosystem :

TOKENS	GFI	CFG	TRU
Average Return	37.41%	18.09%	11.86%

Table 3.2.19 *RWA Ecosystem Average Return Q4*

Average Return RWA Ecosystem :

$$\frac{37.41\% + 18.09\% + 11.86\%}{3} = 22.45\%$$

C. Inter-Ecosystems Conflict Edges

Based on the direction of return movements of each quartile, we can build 'conflict edges' (negative relationships) between ecosystems as follows :

AI Season :

	GameFi	DeFi	L1/L2	RWA
AI	√	√	X	X

Table 3.3.1 *AI Season Conflicts*

DeFi Season :

	AI	GameFi	L1/L2	RWA
DeFi	√	√	√	√

Table 3.3.2 *DeFi Season Conflicts*

Bitcoin Dominance Season :

	AI	GameFi	DeFi	L1/L2	RWA
BTC.D	√	√	√	√	√

Table 3.3.3 *Bitcoin Dominance Season Conflicts*

GameFi + L1/L2 Season :

	AI	DeFi	RWA
GameFi L1/L2	X	X	X

Table 3.3.4 *GameFi and L1/L2 Season Conflicts*

D. Implementation To Graph

Based on the data, the graph consists of six nodes, each representing a major cryptocurrency ecosystem. An edge between two nodes indicates a conflict, highlighting a negative correlation that must be considered in portfolio allocation.

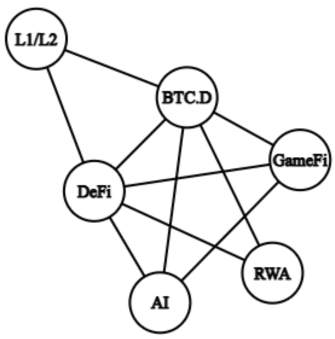


Fig 3.4.1 *The Graph Result (without code)*
Source : https://csacademy.com/app/graph_editor/

Welsh-Powell Algorithm is applied, where each colour represents a group of tokens that can be bought or held together, while avoiding conflicts with other tokens.

Crypto Ecosystem	Degree	Colour
BTC.D	5	Red
DeFi	5	Blue
AI	3	Green
GameFi	3	Orange
Layer1/Layer2	2	Green
RWA	2	Green

Table 3.4.1 *Welsh-Powell Algorithm*

Result of Graph Colouring :

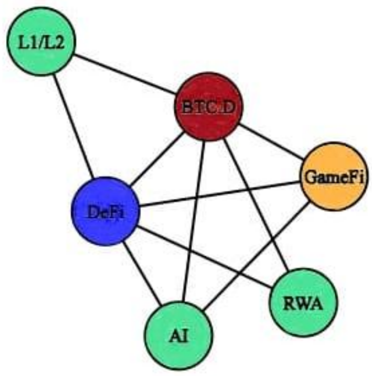


Fig 3.4.2 *The Coloured Graph Result (without code)*
Source : Writer's own illustration

Therefore, the chromatic number of the graph $\chi(G) = 4$.

Graph and Welsh-Powell Algorithm Code :

```python
import networkx as nx
import matplotlib.pyplot as plt

# Nodes (ecosystems)
ecosystems = ['AI', 'GameFi', 'DeFi', 'BTC.D', 'L1/L2', 'RWA']

# Conflict edges
conflicts = [
    ('AI', 'GameFi'),
    ('AI', 'DeFi'),
    ('DeFi', 'GameFi'),
    ('DeFi', 'AI'),
    ('DeFi', 'L1/L2'),
    ('DeFi', 'RWA'),
    ('BTC.D', 'AI'),
    ('BTC.D', 'GameFi'),
    ('BTC.D', 'DeFi'),
    ('BTC.D', 'L1/L2'),
    ('BTC.D', 'RWA'),
]

# Create Graph
G = nx.Graph()
G.add_nodes_from(ecosystems)
G.add_edges_from(conflicts)

# Welsh-Powell Algorithm
def welshPowell(graph):
    sortedNodes = sorted(graph.nodes(), key=lambda x: graph.degree(x), reverse=True)
    colour = {}
    currColour = 0

    for node in sortedNodes:
        if node not in colour:
            colour[node] = currColour
            for otherNode in sortedNodes:
                if otherNode not in colour:
                    if all(colour.get(neigh) != currColour for neigh in graph.neighbors(otherNode)):
                        colour[otherNode] = currColour
            currColour += 1

    return colour
```

Fig 3.4.3 *Graph Creation and Welsh-Powell Algorithm (1)*

Source : *Writer's own code*

```python
# Apply The Algorithm To The Graph
coloring = welshPowell(G)

# Colour Names
colourSet = ['red', 'blue', 'green', 'orange', 'purple', 'yellow']
nodeColours = [colourSet[coloring[node]] for node in G.nodes()]

# Draw the graph
plt.figure(figsize=(8, 6))
pos = nx.spring_layout(G, seed=42)
nx.draw(G, pos, with_labels=True, node_color=nodeColours, node_size=1500, font_weight='bold', edge_color='gray')
plt.title("Cryptocurrency Ecosystem Conflict Graph\n(Welsh-Powell Coloring Applied)", fontsize=13)
plt.show()

# Print coloring result
print("Graph Coloring Result (Chromatic Number = {}):".format(len(set(coloring.values()))))
for node, color in coloring.items():
    print(f"{node}: Color {colourSet[color]}")
```

Fig 3.4.4 *Graph Creation and Welsh-Powell Algorithm (2)*
Source : Writer's own code

Result of the Code :

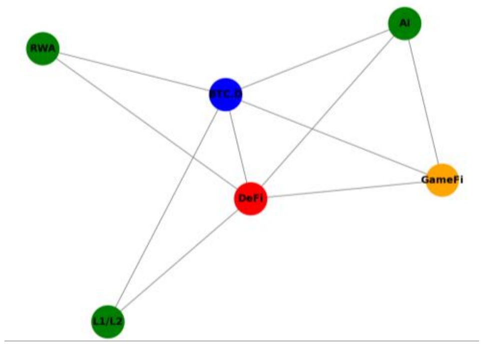


Fig 3.4.5 *Code Execution*

IV. Result and Discussion

From Fig 3.4.2 and Fig 3.4.5, we can conclude that nodes with different colours represent ecosystems whose tokens shouldn't be held at the same time during a specific season. In contrast, nodes with the same colour mean ecosystems that are safe to be bought and held together at the same period. Bitcoin Dominance (BTC.D) affects all ecosystems.

From this graph, several strategies can be made to maximize profit and avoid conflicts:

- During an AI season, it is optimal to allocate your portfolio to AI and RWA tokens while avoiding conflicting ecosystems like GameFi and DeFi. Since, Layer 1 and Layer 2 aren't conversely related to AI then you can keep holding them in your portfolio during this period, and vice versa.
- Since Bitcoin Dominance (BTC.D) negatively affects most ecosystems. Investors or traders can minimize altcoins in their portfolio and shift to stablecoins. Or It would be better to sell your current holdings and buy them again when the time is right (when BTC.D is experiencing downturns).
- During GameFi or Infrastructure Layer 1/Layer 2 season, we can hold the majority of our tokens because there is no negative correlation between two ecosystems in that time period.
- During a DeFi season, it almost acts like when Bitcoin Dominance are rising because every ecosystem is negatively correlated to DeFi ecosystem.
- Finally, one of the most effective strategies is the "Early Entry Strategy". If a particular quarter is known to be a GameFi season or Layer 1/Layer 2 season, then it would be best to buy the tokens from that ecosystem toward the end of the preceding quarter.

V. Graph Code Result

This program allows the user to input their current market season. If the input is valid, the program will provide recommendations on which token ecosystems to **Buy/Hold** or **Avoid/Sell** based on the selected season.

If the input is invalid or unrecognized, the program will notify the user that the season is unknown and tell them to enter a valid season.

A. Writer's Cryptocurrency Ecosystem Selection Code

```c
#include <stdio.h>
#include <string.h>

typedef enum {
    AI,
    DeFi,
    BTC_D,
    GameFi,
    Unknown
} Season;

Season currSeason(const char *input) {
    if (strcmp(input, "AI") == 0) {
        return AI;
    }
    if (strcmp(input, "DeFi") == 0) {
        return DeFi;
    }
    if (strcmp(input, "BTC.D") == 0) {
        return BTC_D;
    }
    if (strcmp(input, "GameFi") == 0 || strcmp(input, "L1-L2") == 0) {
        return GameFi;
    }
    return Unknown;
}

int main(void) {
    char input[64];

    printf("Enter current season (exactly one of: AI, DeFi, BTC_D, GameFi, L1-L2): ");
    if (!fgets(input, sizeof(input), stdin)) {
        return 1;
    }

    input[strcspn(input, "\n")] = '\0';

    Season s = currSeason(input);

    printf("\n=== Portfolio Advice for %s Season ===\n\n", input);
    switch (s) {
        case AI:
            printf("Safe to BUY/HOLD: AI, RWA, L1/L2\n");
            printf("Avoid/SELL:       GameFi, DeFi\n\n");
```

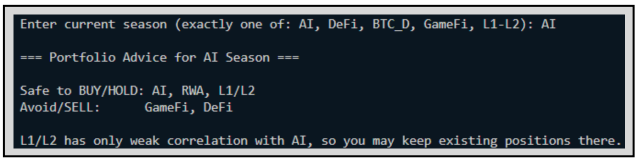
Fig 5.1.1 *Cryptocurrency Ecosystem Selection Code (1)*
Source : Writer's own code

```c
            printf("L1/L2 has only weak correlation with AI, so you may keep existing positions there.\n");
            break;

        case DeFi:
            printf("Safe to BUY/HOLD: DeFi\n");
            printf("Avoid/SELL:       AI, GameFi, L1/L2, RWA\n\n");
            printf("Similar to a BTC.D season: most alt ecosystems conflict with DeFi now.\n");
            break;

        case BTC_D:
            printf("Safe to BUY/HOLD: Bitcoin (BTC) or stablecoins\n");
            printf("Avoid/SELL:       AI, GameFi, DeFi, L1/L2, RWA\n\n");
            printf("All altcoin ecosystems tend to decline when BTC dominance rises.\n");
            break;

        case GameFi:
            printf("Safe to BUY/HOLD: GameFi, L1/L2\n");
            printf("Avoid/SELL:       (no conflicts)\n\n");
            printf("This is miracle season: most ecosystems rise in price.\n");
            break;

        default:
            printf("Unknown season. Please enter exactly: AI, DeFi, BTC.D, GameFi, or L1-L2\n");
            break;
    }

    return 0;
}
```

Fig 5.1.2 Cryptocurrency Ecosystem Selection Code (2)
Source : Writer's own code

B. Code Execution

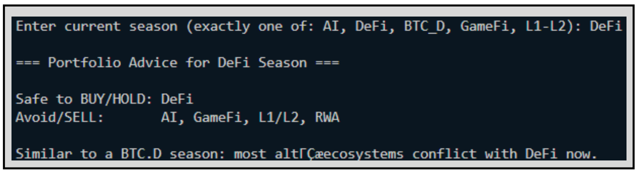
AI Season :



```
Enter current season (exactly one of: AI, DeFi, BTC_D, GameFi, L1-L2): AI

=== Portfolio Advice for AI Season ===

Safe to BUY/HOLD: AI, RWA, L1/L2
Avoid/SELL:      GameFi, DeFi

L1/L2 has only weak correlation with AI, so you may keep existing positions there.
```

Fig 5.2.1 *AI Season*

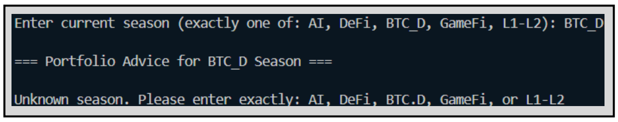
DeFi Season :



```
Enter current season (exactly one of: AI, DeFi, BTC_D, GameFi, L1-L2): DeFi

=== Portfolio Advice for DeFi Season ===

Safe to BUY/HOLD: DeFi
Avoid/SELL:       AI, GameFi, L1/L2, RWA

Similar to a BTC.D season: most altΓÇæecosystems conflict with DeFi now.
```

Fig 5.2.2 *DeFi Season*

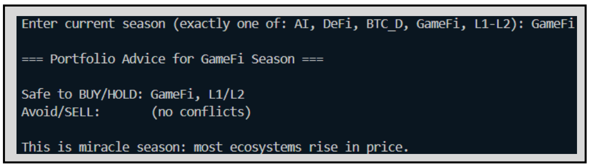
BTC.D Season :



```
Enter current season (exactly one of: AI, DeFi, BTC_D, GameFi, L1-L2): BTC_D

=== Portfolio Advice for BTC_D Season ===

Unknown season. Please enter exactly: AI, DeFi, BTC.D, GameFi, or L1-L2
```

Fig 5.2.3 *Bitcoin Dominance Season*

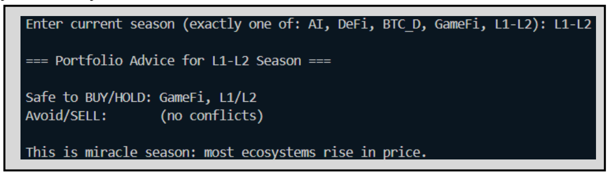
GameFi Season :



```
Enter current season (exactly one of: AI, DeFi, BTC_D, GameFi, L1-L2): GameFi

=== Portfolio Advice for GameFi Season ===

Safe to BUY/HOLD: GameFi, L1/L2
Avoid/SELL:       (no conflicts)

This is miracle season: most ecosystems rise in price.
```

Fig 5.2.4 *GameFi Season*

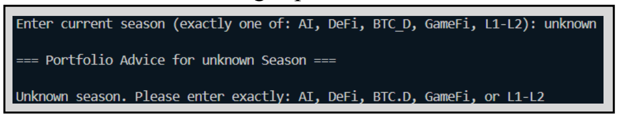
Layer 1/Layer 2 Season :



```
Enter current season (exactly one of: AI, DeFi, BTC_D, GameFi, L1-L2): L1-L2

=== Portfolio Advice for L1-L2 Season ===

Safe to BUY/HOLD: GameFi, L1/L2
Avoid/SELL:       (no conflicts)

This is miracle season: most ecosystems rise in price.
```

Fig 5.2.5 *Layer1/Layer 2 Season*

Unknown Season or Wrong Input :



```
Enter current season (exactly one of: AI, DeFi, BTC_D, GameFi, L1-L2): unknown

=== Portfolio Advice for unknown Season ===

Unknown season. Please enter exactly: AI, DeFi, BTC.D, GameFi, or L1-L2
```

Fig 5.2.6 *Unrecognized Season*

VI. Conclusion

This paper proposed a graph-theoretic approach to optimizing cryptocurrency token selection using the Welsh-Powell graph colouring algorithm. There are six nodes representing cryptocurrency ecosystem such as Artificial Intelligence (AI), Game + Finance (GameFi), (Decentralized Finance (DeFi), Bitcoin Dominance (BTC.D), Real World Assets (RWA), and Layer 1/Layer 2 Infrastructure. Strategies such as conflict aware allocation for Bitcoin Dominance or DeFi season and Early Entry strategy were aimed to help investors or traders minimize risk and maximize their profit during a specific season.

But, the cryptocurrency market is very volatile and it shifts rapidly due to news, regulations, and technological trends. Therefore, investors or traders are advised to conduct their own research (DYOR) before making any decisions.

VII. Appendix

The source code that is used in the paper can be found in : https://github.com/GeraldoA07/DiscreteMathCode

VIII. Acknowledgement

The writer would like to express sincere gratitude to Dr. Ir. Rinaldi Munir, M.T., for his dedication in teaching Discrete Mathematics for K-1 throughout the second semester. The writer also appreciates the support and encouragement from their family and friends during the completion of this paper. Lastly, the writer gives thanks to God for His grace, and strength throughout this journey.

References

[1] Kaspersky. "What is Cryptocurrency and how does it work?". https://www.kaspersky.com/resource-center/definitions/what-is-cryptocurrency. Accessed 17 June 2025.

[2] Mondal, B., & De, K. 2017. "An Overview Applications of Graph Theory in Real Field". https://www.academia.edu/34909927/An_Overview_Applications_of_Graph_Theory_in_Real_Field#loswp-work-container. Accessed 18 June 2025.

[3] Munir, R. 2024. "Graf (Bag. 1)". https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/20-Graf-Bagian1-2024.pdf. Accessed 18 June 2025.

[4] Munir, R. 2024. " Graf (Bag. 3)". https://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2024-2025/22-Graf-Bagian3-2024.pdf. Accessed 18 June 2025.

[5] CoinGecko. "Cryptocurrency Prices, Charts and Market Capitalizations. https://www.coingecko.com/. Accessed 19 June 2025.

Statement of Originality

I hereby declare that the paper I have written is my own original work, not an adaptation or translation of someone else's work, and not an act of plagiarism.

Bandung, 19 June 2025

Geraldo Artemius
13524005