

Wano's Web

Exploring Character Networks in One Piece

Christopher Santiago

College of Engineering and Computer Science

University of Central Florida

Orlando, Florida 32826-5010

Email: ch295541@ucf.edu

Abstract—The exploration of network science, particularly social network analysis, offers powerful insights into the interplay of characters within a narrative. This study applies various network analysis techniques to the character interactions in the Wano Arc of the One Piece anime. The network represents relationships and interactions among characters, providing a nuanced understanding of their centrality and influence.

In this analysis, centrality measures such as degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality are employed to gauge the significance of individual characters. The presence and absence of the central character, Luffy, are examined to unravel shifts in narrative dynamics.

Methodologies for the analysis are detailed, encompassing the extraction of character interactions and the computation of centrality metrics. The results, presented in the Analysis section, illuminate key findings. Notably, Luffy emerges as a central character, significantly shaping the narrative. However, removing Luffy redistributes narrative influence, highlighting the critical roles of other characters, including Mononosuke, Kin'emon, and Zoro.

The narrative structure proves to be resilient, showcasing a dynamic ensemble where various characters contribute meaningfully to the storyline. Insights derived from the centrality measures underscore the evolving nature of the narrative, challenging the traditional notion of Luffy as the sole main character.

This analysis contributes to the broader understanding of narrative structures in anime and storytelling, emphasizing the collaborative and distributed nature of character influence within complex story arcs.

I. INTRODUCTION (*Heading 1*)

In the expansive world of One Piece, narratives are woven intricately through the interactions and relationships of its diverse cast of characters. The Wano Arc stands as a testament to the series' complexity, offering a rich tapestry of storylines, alliances, and conflicts. In our exploration, we delve into the heart of this narrative through the lens of network analysis, aiming to unravel the dynamics that govern the interactions among characters.

Network science provides a unique vantage point, allowing us to visualize and quantify the relationships that shape the story. The characters, like nodes in a vast network, contribute to the overarching narrative, each playing a distinct role in the unfolding saga. Our analysis employs advanced methodologies, drawing inspiration from social network analysis, to dissect the structure of the Wano Arc character network.

As we venture into this analysis, our objectives are twofold. Firstly, we seek to identify the central characters whose influence reverberates throughout the network, defining the narrative's core. Secondly, we explore the narrative's resilience by investigating how its structure adapts when a central character, in this case, Luffy, is temporarily removed. These insights promise a deeper understanding of how characters collectively shape the narrative landscape.

Join us on this journey through the corridors of Wano, where characters, alliances, and the essence of storytelling converge. Through the application of network analysis, we aim to extract patterns, unveil complexities, and offer a fresh perspective on the collaborative nature of character influence in the vibrant world of One Piece.

II. HISTORY

A. Punk Hazard Arc

The road to Wano was set in motion during the Punk Hazard Arc. Trafalgar Law, a prominent character and a member of the Worst Generation, proposed an alliance with the Straw Hat Pirates, led by Monkey D. Luffy, to take down one of the Four Emperors of the Sea, Kaido. This alliance planted the seeds for the epic clash that would unfold in Wano.

B. Dressrosa Arc

The alliance gained momentum in the Dressrosa Arc, where Luffy, Law, and their allies, including the Samurai of Wano, faced formidable challenges. The Dressrosa Arc solidified the bond between the Straw Hat Pirates and the Wano Samurai, setting the stage for their united front against the tyrannical rule of Kaido.

C. Zou Arc

The journey continued with the Zou Arc, where the Straw Hat Pirates reached the elephantine island of Zou. Here, they

discovered the devastating impact of Kaido's actions on the Mink Tribe, further fueling their resolve to confront the Emperor of the Sea.

D. Whole Cake Island Arc

As the crew advanced, the Whole Cake Island Arc unfolded, showcasing Luffy's confrontation with Big Mom, another of the Four Emperors. This arc not only added layers to the overarching narrative but also revealed the complexities of the power dynamics at play in the world of One Piece.

E. Reverie Arc

The Reverie Arc provided glimpses into the global consequences of the unfolding events, emphasizing the interconnectedness of the world, and setting the stage for a colossal clash between powerful forces.

The Wano Arc holds profound significance in the One Piece narrative. It serves as a battleground where the Straw Hat Pirates, their allies, and the Samurai of Wano unite against Kaido, a symbol of tyranny. Beyond the physical conflict, Wano represents a turning point in the series, where alliances forged in the crucible of previous arcs converge to reshape the world order.

The themes of freedom, justice, and the indomitable spirit of the characters converge in Wano, making it a pivotal chapter in the epic tale of One Piece.

III. HYPOTHESIS AND DATA COLLECTION

A. Data Collection

The foundation of this project rests on a dual approach to data collection, combining personal expertise with the collaboration of dedicated fans. Having been an avid viewer of the One Piece anime since its inception in 1997, my deep familiarity with the series provided a solid groundwork for analysis.

However, recognizing the expansive nature of the Wano Arc, which spanned from 2018 to 2022, and the intricate web of character interactions, I embraced a complementary strategy. To ensure a comprehensive dataset, I turned to a crowdsourced wiki, harnessing the collective knowledge and meticulous documentation of fellow enthusiasts. This collaborative effort became instrumental in filling gaps and capturing nuances in character dynamics that might have faded from memory over the arc's multi-year duration. [1]

An additional aspect of our data collection strategy warrants mention, specifically pertaining to the initial refinement of our network. The Wano Arc introduces a staggering cast, boasting over 350 named characters. Recognizing the need for visual clarity and analytical efficiency, we made a deliberate

decision to focus our attention on the top 50 characters most frequently featured in the manga panels [2].

B. Hypothesis 1

In our pursuit of understanding the intricate character dynamics within the Wano Arc, we formulated two fundamental questions. Firstly, our aim is to identify central characters, those pivotal to the narrative's structure. Through an assessment of the network, we anticipate encountering the following characters associated with distinct groups:

1) Pirate

- Luffy
- Zoro
- Sanji
- Nami
- Chopper
- Brook
- Franky
- Kaido
- Big Mom

2) Ninja

- Kin'emon
- Mononosuke

3) Mink

- Inuarashi
- Nekomamushi
- Carrot

C. Hypothesis 2

Our second objective involves selecting a central character, where we expect Luffy to wield the greatest network influence. By foreseeing the significant impact of Luffy's absence, we anticipate notable alterations in connections and the prominence of characters with high centrality measures.

IV. GRAPHS AND MEASUREMENTS

In Figure 1 below, we present the graph featuring the top 50 characters most frequently observed in manga panels. The edges between nodes signify interactions between characters within the anime. This undirected graph maintains a uniform edge weight of 1, disregarding any variations. Our analysis, conducted with the aid of the Gephi software, will delve into five centrality measures. This exploration aims to identify and establish the primary characters of the Wano Arc, aligning with the first hypothesis. Subsequently, our analytical journey will lead us to draw conclusive insights regarding the second hypothesis.

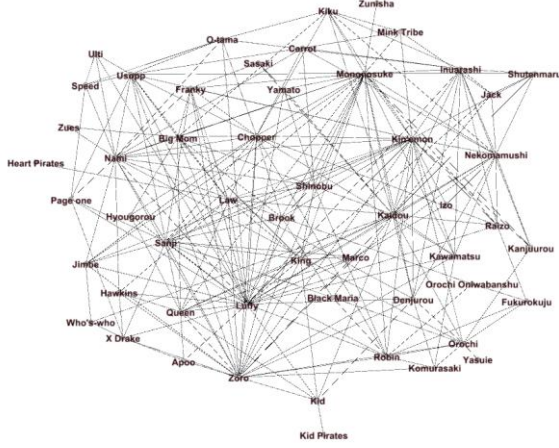


Fig 1. This graph shows the nodes of our network for context of our analysis.

A. Degree Centrality

In our analysis of the One-Piece character network, we've identified 'central characters.' But what does that mean? In the context of network analysis, central characters are those who play pivotal roles in connecting with the most other characters. They serve as key influencers, bridges, or even anchors within the network, and their interactions can significantly shape the narrative.

Therefore, we begin with degree centrality. Degree centrality provides insights into the level of connectivity of a node, highlighting nodes that serve as pivotal connectors within the network. Nodes with high degree centrality are often considered influential or central in facilitating information flow or interactions within the network. Below, Table I display the top 10-degree centrality ranking for our graph.

Table 1. TOP 10 DEGREE CENTRALITY

Rank	Top 10 Degree Centrality Nodes	
	Name of Node	Degree
1	Luffy	33
2	Kin'emon	31
3	Mononosuke	30
4	Zoro	25
5	Kaidou	24
6	Nami	20
7	Sanji	19
8	Chopper	19
9	Nekomamushi	18
10	Inuarashi	17

For an undirected graph, the degree centrality of a node i is calculated as the total number of edges incident to i divided by the total number of nodes in the graph. We described this formula more formally below.

$$C_D(n_i) = \frac{\sum_{j=1}^n e_{ij}}{n} \quad (1)$$

Examining the top 10-degree centrality members confirms that all of them align with our initial hypothesis, hypothesis 1.

B. Closeness Centrality

Closeness centrality assesses the proximity of a node to all others in the network. A node is deemed significant in closeness centrality if it is relatively close to all other nodes. In our network context, closeness centrality gauges how swiftly a character can connect with all others. Characters exhibiting high closeness centrality demonstrate efficient access and interactions with their peers. As depicted in Table 2 below, our top-10 rankings remain consistent.

Closeness is based on the inverse of the geodesic distance of each node to every other node in the network, as shown here:

$$C_c = \frac{1}{\sum_{j=1}^n d(n_i, n_j)} = \left[\sum_{j=1}^n d(n_i, n_j) \right]^{-1} \quad (2)$$

Table 2. TOP 10 CLOSNESS CENTRALITY

Rank	Top 10 Closeness Centrality Nodes	
	Name of Node	Closeness
1	Luffy	0.7027
2	Kin'emon	0.65
3	Mononosuke	0.65
4	Zoro	0.65
5	Kaidou	0.6190
6	Nami	0.5977
7	Sanji	0.5977
8	Chopper	0.5843
9	Nekomamushi	0.5474
10	Inuarashi	0.5474

As depicted in Table 2 above, our top-10 rankings remain consistent. The fact that the top 10 rankings remain unchanged for both measures indicates a consistent pattern in the network. The characters identified as important by degree

centrality are also identified as central in terms of closeness.

C. Betweenness Centrality

Betweenness centrality quantifies the frequency with which a node lies on the shortest path between two other nodes in the network. This centrality metric gauges the significance of a node in facilitating the flow of information and connections across the network. The calculation for betweenness centrality is expressed by the formula:

$$C_B = \sum_{i,k} \frac{g_{ikj}}{g_{ik}}, \text{ where } i \neq k \neq j \quad (3)$$

Betweenness centrality serves as a tool to pinpoint characters functioning as pivotal bridges or intermediaries between distinct groups or storylines within the network. These characters play a crucial role in upholding connections throughout the network. In Table 3 below, it's noteworthy that four new characters have entered our top-10 list. The inclusion of these characters is logical – Law and Kid hold leadership roles as captains of their respective crews, Orochi leads a distinct faction within our group of villains, and Robin engages in interactions across all groups.

Table 3. TOP 10 BETWEENNESS CENTRALITY

Rank	Top 10 Betweenness Centrality Nodes	
	Name of Node	Betweenness
1	Luffy	211.36
2	Kaidou	142.85
3	Mononosuke	141.08
4	Kin'emon	133.56
5	Zoro	107.02
6	Nami	101.67
7	Orochi	78.47
8	Law	58.93
9	Kid	51.33
10	Robin	48.30

D. Page Rank

The PageRank algorithm, developed by Google, is a variant of eigenvector centrality and was employed to derive these values. PageRank determines the importance of a node relative to other nodes in the network. In our network's context, characters with high PageRank are frequently central to the main storyline, with their actions and decisions carrying significant narrative weight. As shown in the results of this metric, many familiar characters reappear, with one

noteworthy addition: Big Mom, who plays a pivotal role in the overarching narrative.

Table 4. TOP 10 PAGERANK

Rank	Top 10 PageRank	
	Name of Node	PageRank
1	Luffy	0.0487
2	Mononosuke	0.0424
3	Zoro	0.0383
4	Kin'emon	0.0382
5	Kaidou	0.0354
6	Nami	0.0335
7	Sanji	0.0304
8	Chopper	0.0297
9	Nekomamushi	0.0237
10	Big Mom	0.0236

E. Eigenvector Centrality

Eigenvector centrality assesses a node's significance in a network, considering the importance of its neighbors. Building upon the concept of degree centrality, it gauges a character's importance by evaluating their connections to other influential characters. High eigenvector centrality suggests that a character is connected to other highly influential characters. The basic equation for eigenvector centrality is as follows:

$$Ax = \lambda x \quad (4)$$

Where x is the eigenvector and λ is the scalar eigenvalue.

Thus, the Table 5 below provides us with connectedness to influential characters.

Table 5. TOP 10 EIGENVECTOR CENTRALITY

Rank	Top 10 Eigenvector Centrality	
	Name of Node	Eigenvector
1	Kin'emon	1.0
2	Luffy	0.947
3	Mononosuke	0.927
4	Zoro	0.767
5	Kaidou	0.739
6	Nekomamushi	0.606
7	Chopper	0.603
8	Inuarashi	0.598
9	Sanji	0.593
10	Nami	0.559

F. Defining the Central Character

Central characters, as we've previously discussed, are the pillars of our narrative. They are the characters who have the most connections, influence, and interactions within the One Piece network. They serve as the cornerstones, driving the storyline, and connecting various character groups and story arcs. In addressing the central inquiry regarding the primary character, our methodology involved determining the main character based on the most favorable average ranking across the five centrality measures. Characters appearing in at least one top 10 were considered potential main characters. As illustrated in Figure 2 below, our findings duly designate Luffy as the principal central character.

- Luffy - 1, 1, 1, 1, 2 = 1.2
- Kin'emon - 2, 2, 4, 4, 1 = 2.6
- Mononosuke - 3, 3, 3, 2, 3 = 2.8
- Zoro - 4, 4, 5, 3, 4 = 4
- Kaido - 5, 5, 2, 5, 5 = 4.4
- Nami - 6, 6, 6, 6, 10 = 6.4
- Sanji - 7, 7, 11, 7, 9 = 8.2
- Chopper - 8, 8, 12, 8, 7 = 8.6
- Nekomamushi - 9, 9, 13, 9, 6 = 9.2
- Law - 15, 13, 8, 12, 11 = 11.8
- Inuarashi - 10, 10, 17, 15, 8 = 12
- Big Mom - 13, 11, 13, 14, 10 = 12.2
- Robin - 16, 18, 10, 16, 17 = 15.4
- Orochi - 19, 17, 7, 14, 22 = 15.8
- Kid - 27, 27, 9, 22, 25 = 22

Fig. 2 Average Centrality Ranking Across the 5 Measures

G. Egonetwork Removal

Now, consider this: What happens when we alter this network by removing one of these central characters? How does it affect the overall narrative? To answer these questions, we'll conduct an analysis to explore the consequences of 'removing' a central character, symbolically, from the network.

For our analysis, we've chosen to focus on Luffy, the central character and captain of the Straw Hat Pirates. Luffy's presence in the network is immense, as he connects with allies, rivals, and various factions. Removing him, even in theory, allows us to understand the profound influence he has on the story and the network dynamics.

H. Network Analysis After Removal

Figures 3 and 4, below, provides us insights into our centrality measures with and without Luffy's inclusion.

NETWORK ANALYSIS AFTER REMOVAL

Top 10 Betweenness Centrality		Top 10 Closeness Centrality	
Label	Betweenness Centrality	Label	Closeness Centrality
Without Luffy			
Mononosuke	107.42712	Mononosuke	0.64517
Zoro	103.04789	Kin'emon	0.64517
Kaido	100.91329	Zoro	0.64517
Kin'emon	104.85547	Nami	0.70321
Nami	102.05057	Sanji	0.70321
Orochi	91.05057	Chopper	0.70321
Sanji	43.07237	Big Mom	0.58842
Chopper	41.40348	Law	0.58842
Law	41.21754	Orochi	0.58842
Kid	30.0		
With Luffy			
Luffy	211.02197	Luffy	0.70321
Kaido	142.04558	Kin'emon	0.64517
Mononosuke	141.04558	Mononosuke	0.64517
Kin'emon	103.04789	Zoro	0.64517
Zoro	103.04789	Kaido	0.64517
Nami	102.05057	Nami	0.70321
Orochi	91.05057	Sanji	0.70321
Sanji	43.07237	Chopper	0.70321
Chopper	41.40348	Big Mom	0.58842
Law	41.21754	Law	0.58842
Kid	30.0	Orochi	0.58842

Fig. 3 Top 10 Betweenness and Closeness Centralities with and without Luffy

NETWORK ANALYSIS AFTER REMOVAL CONT.

Top 10 Eigenvector Centrality		Top 10 PageRank	
Label	Eigenvector Centrality	Label	PageRank
Without Luffy			
Kin'emon	1.0	Mononosuke	0.04545
Mononosuke	0.96177	Zoro	0.04545
Zoro	0.70811	Kin'emon	0.04545
Kaido	0.77553	Kaido	0.04545
Nekomamushi	0.62762	Nami	0.04545
Inuarashi	0.61702	Sanji	0.04545
Chopper	0.50741	Chopper	0.04545
Sanji	0.57682	Big Mom	0.04545
Nami	0.54332	Law	0.04545
Ussop	0.48275	Nekomamushi	0.04545
With Luffy			
Kin'emon	1.0	Luffy	0.04545
Mononosuke	0.96177	Mononosuke	0.04545
Zoro	0.70811	Zoro	0.04545
Kaido	0.77553	Kin'emon	0.04545
Nekomamushi	0.62762	Kaido	0.04545
Inuarashi	0.61702	Nami	0.04545
Chopper	0.50741	Sanji	0.04545
Sanji	0.57682	Chopper	0.04545
Nami	0.54332	Big Mom	0.04545
Ussop	0.48275	Law	0.04545

Fig. 4 Top 10 Eigenvector Centrality and PageRank with and with Luffy

Removing Luffy redistributes centrality and elevates characters like Mononosuke and Kin'emon, highlighting their importance in the network. Characters who maintain their positions in the top 10 of centrality measures demonstrate that their roles are pivotal to the storyline. Their interactions, influence, and connections continue to be essential for the network's structure.

V. CONCLUSION AND FINAL REMARKS

Upon conducting a comprehensive examination, encompassing our initial analysis and the subsequent exploration following the removal of our central character, Luffy, we now turn our attention to reflection. While hypothesis 1 largely aligned with expectations, featuring some nuances for characters like Carrot, Brook, and Franky, it is crucial to note that our analysis concentrated on the top 10 measures. Expanding our scope to the top 12 or 15 may reveal a more comprehensive alignment with our hypothesis.

In contrast, our second hypothesis appears to face challenges, at least on the surface. As we delve deeper into our findings, we can elucidate the factors contributing to these results.

1) *Diverse Network Structure:* One possible conclusion is that the One Piece storyline and the Wano arc, in particular, have a diverse and robust network structure. This diversity means that there are multiple central characters and key players who collectively shape the narrative. Even without Luffy, other central characters, such as Kin'emon and Inuarashi, maintain strong connections and influence within the network.

2) *Narrative Resilience:* The narrative of the Wano arc is structured in a way that it can adapt to changes in character centrality. This resilience suggests that the story is not solely dependent on one character but rather on the interactions and relationships of multiple characters. The absence of Luffy may not disrupt the overall narrative flow, indicating a well-balanced storyline.

3) *Luffy's Evolving Role:* It could also signify that Luffy's role in the network has evolved over the course of the Wano arc. While he remains a central character, other characters and groups have stepped up to share the narrative spotlight. Luffy's centrality may have shifted as the arc progresses, reflecting changes in his alliances and interactions

4) *Network Complexity:* The One Piece world is known for its complexity, with numerous factions, alliances, and interconnected storylines. If Luffy's exclusion has limited impact, it may demonstrate the intricacy of the network, where

the narrative is influenced by multiple factors, not solely reliant on one character.

One final note to further analysis. Perhaps it is worth considering weights in the relationship between nodes.

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