Exploring Lifeline's Top 100 "Best Performance" Osu! Scores Using Graph Theory

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***Abstract*—**This document will want to analyze Lifeline's top 100 "Best Performance" Osu! Scores using graph theory. This document will hopefully find patterns in skill, maps, scores and mappers. Look at key mappers, skills, and maps. This will hopefully lead to a new perspective on this ranked #7 player. This document is written on 6/20/2025.

Keywords—Osu!, Network Analysis, Graph Theory, Lifeline Osu!

I. Introduction (*Heading 1*)

Lifeline is an Osu! player from Indonesia, he is ranked #7 global and ranked #1 from Indonesia. Osu! is a rhythm game where you have to click circles to the beat. There is a Top 100 "Best Performance" Osu! scores in every player profile that show what they're high-ranking scores are. Use graph theory to analyze them.

It would be nice to analyze his scores specifically because it would be a valuable new prespective.

II. Theory

A. Graph

According to adacomputerscience.org, A graph is a data structure that can be used to represent complex, non-linear relationships [1]. Graphs have nodes and edges, sometimes loops and cycles. Here is an image to illustrate the differences between nodes, edges, loops, and cycles.

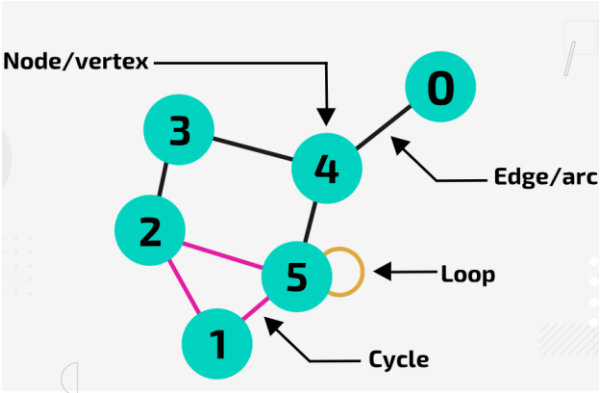

Fig 2.1 Graph Illustration

(Taken from adacomputerscience.org)

As illustrated, a node is an object that is connected to another node. An edge is the connection the objects have with each other or itself. A loop is when an object has a connection with itself. A cycle is when a sequence of objects connected ends with the same object it started off with.

1) Directed Graph

Directed graph is when the connections have a direction pointed from one object to another object or to itself. An undirected graph doesn't have directions. Here is an image to illustrate.

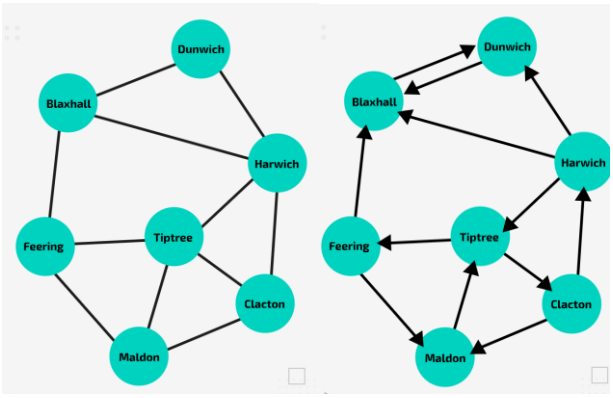

Fig 2.2 a) undirected graph b) directed graph

(Taken from adacomputerscience.org)

2) Weighted Graph

Weighted graph is when the connections have a number that usually represents the strength of the connections between the objects or itself. Here is an image to illustrate.

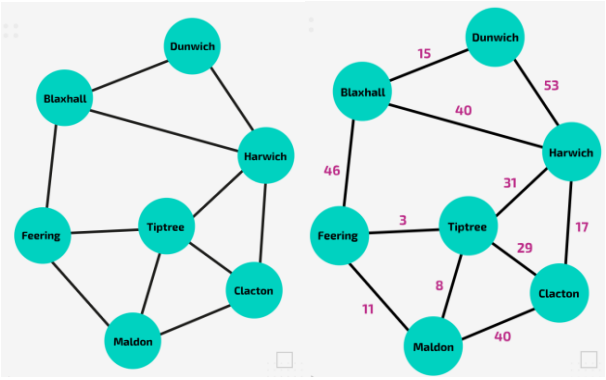

Fig 2.3 a) unweighted graph b) weighted graph

(Taken from adacomputerscience.org)

3) Conclusion

These directions and weights will help analyze -quantify for weight- the complex connections between objects. This will certainly make looking for patterns in the complex and rich graph easier. Keep in mind that the images will be shown here are very simplified. In the real world, where graphs like this may appear, graphs will sometimes consist of thousands of nodes.

B. Graph Centrality

According to cambridge-intelligence.com Centrality measures are a vital tool for understanding networks, often also known as graphs. These algorithms use graph theory to calculate the importance of any given node in a network. They cut through noisy data, revealing parts of the network that need attention – but they all work differently. Each measure has its own definition of 'importance', so you need to understand how they work to find the best one for your graph visualization applications. Prepare Your Paper Before Styling [2].

1) Degree Centrality

Degree centrality is the total number of connections connected to an object. Here is the equation for the degree centrality of a graph.

$$CD(v) = deg(v) / (n-1)$$

- $deg(v)$ is the number of edges incident to v.
- $(n-1)$ is the normalization factor.

The higher the degree centrality, the more connections the object has.

2) Betweenness Centrality

Betweenness Centrality is the total quality of connections connected to an object. Here is the equation for the degree centrality of a graph.

$$CB(v) = \sum \sigma st(v) / \sigma st$$

- $\sigma st(v)$ is number of those paths passing through.
- σst is total number of shortest paths from node s to node t.

The higher the betweenness centrality, the object has connections between different categories.

3) Closeness Centrality

Betweenness Centrality is close an object is to every other object in the graph. Here is the equation for the degree centrality of a graph.

$$CC(v) = 1/ (\sum t \in V \, d(v,t))$$

- e $d(v,t)$ is the shortest path distance between vertices v and □

The higher the closeness centrality, the object is more aligned with every other object in the graph it makes it central to the graph.

4) Conclusion

These graph centralities will help analyze the complex connections between objects. This will certainly make looking for patterns in the complex and rich graph easier. Keep in mind that the images will be shown here are very simplified. In the real world, where graphs like this may appear, graphs will sometimes consist of thousands of nodes.

C. Osu! Scores

Lifeline's Top 100 "Best Performance" Osu! Scores are the scores set on a rhythm game called Osu! that are in the "Best Performance" section of Lifeline's profile.

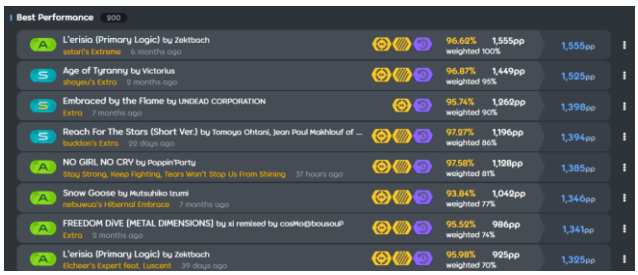

Fig 2.4 Lifeline's Top 100 "Best Performance" Osu! Scores sample

(Taken from osu.ppy.sh)

D. Patterns

Patterns -for the purposes of this document- are the similarities to these graph examples.

1) *Pattern 1*
2) *Pattern 2*

III. Methodology

After the theory is understood, the data is ready to be started to be collected.

A. Collecting Data

IV. Results

V. Conclusion

References

[1] Ada Computer Science, "Graphs." [Online]. Available: https://adacomputerscience.org/concepts/struct_graph . [Accessed: 20-June-2025].

[2] Cambridge Inteligence, "keylines faqs social network analysis." [Online]. Available: https://cambridge-intelligence.com/keylines-faqs-social-network-analysis/. [Accessed: 20- June-2025].

PERNYATAAN

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

Bandung, 20 Juni 2025

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