


Rumble Flow++ Interactive Visual Analysis of Dota2 Encounters

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Abstract

In the last decade, the popularity of ESports has grown rapidly. The financial leader in the tournament scene is Dota2, a complex and strategic multiplayer game. Analysis and exploration of game data could lead to better outcomes. Available data resources include the combat log, which logs every event at an atomic level and excels at providing great detail at the expense of readability, and concise third-party summaries that provide little detail. In this paper, we introduce Rumble Flow++, a web-based exploratory analysis application that provides details in an easy-to-understand manner while providing meaningful aggregations. Rumble Flow++ supports exploration and analysis at different levels of granularity. It supports analysis at the level of the entire match, at the level of individual team fights, and at the level of individual heroes. The user can easily switch between levels in a fully interactive environment. Rumble Flow++ provides much more detail than a summary visualization typically uses, and much better readability than an atomic log file.

1. Introduction

Similar to traditional sports, professional ESports teams are competing in tournaments of varying size all around the globe with millions of spectators watching and following their progress [RC19]. The ESport scene is still expanding and can nowadays even be compared to sports like soccer, basketball or football. It is even more popular and established in Asia compared to the Western world [Cha18]. For example, the annual Dota2 tournament, The International (TI), with a combined value of more than 34 million USD in 2019 has been on par with sports tournament prize money for years. From the viewer's perspective, Dota2 matches are characterized by a dramatic arc of tension resulting from the inevitable conflicts between teams and their uncertain outcome [Chr15]. Teamfights are consequently an important part of the game in order to win and are exciting to watch as well. Thus they create motivation to look further into them. When it comes to logging actions, ESports offer an advantage over traditional sports because logging can be easily implemented.

Sports data analytics in general is used extensively to improve team performance. Visual analytics offers additional opportunities because sports data often has a spatial component. Perin et.al [PVS*18] provide a recent survey on visual analytics in sports. Du and Yuang [DY21] provide another overview of visualization and visual analysis in competitive sports. Several public Dota2 sites provide basic visualizations and aggregated statistics, but often neglect the time aspect. Visualizing this type of information is a common demand in order to increase readability and communicate the data in a clear way [RFW20]. Teamfight summaries (see Figure 1)

represent an example of a simple visualization of aggregated data for Dota2 as offered by OpenDota, open source data platform [ope]. Li et al. [LXC*17] developed a visual analytics system to support game designers for Multiplayer Online Battle Arena (MOBA) games. We deal with the same type of games, but our primary users are players, not the game designers.

In this paper, we introduce a visual analysis system for analysis of Dota2 data and analysis tasks that we have identified. Unlike available Dota2 visualization tools, we consider the temporal component and rely on the coordinated multiple views paradigm [Rob07] to provide different perspectives on data. Our approach supports exploration and analysis at different levels, overview of a match, more detail analysis of a teamfight, and exploration of individual hero's characteristics. Our system features the Dota2 Rumble Flow, an interactive graph visualization designed to help with teamfight analysis based on interactions between players, the Cumulative Damage Curve, a line chart focusing on actions of a single player throughout a teamfight, and the Network and Experience Graph, a well known visualization in the Dota2 community which gives information on when a team was in the lead and the significance of the lead itself. The newly proposed system efficiently fills the gap between detailed game logs, which are difficult to understand, and aggregated summaries, which often do not provide enough details for in-depth analysis.

2. The Game of Dota2

In this section we provide a short introduction to Dota2. Dota2 is a popular MOBA game. These games typically feature very strategic

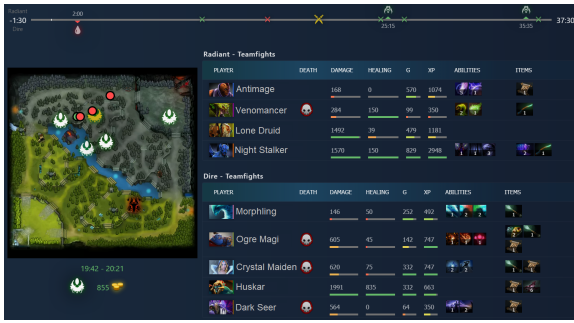


Figure 1: The teamfight summary provided by opendota for the third teamfight (see yellow crossed swords on the timeline at the top) in a public match, match id: 5685650570. Player names were replaced with hero names

gameplay and are highly competitive. They are designed to take place in a limited space that basically looks the same for every game, similar to the board of a board-game. In the case of Dota2 the map is split diagonally between the Radiant side and the Dire. There are two teams with five players each and every player picks a character, also called hero or champion for the match. Ultimately, the goal is to destroy the enemy team's base. In order to do so, opposing heroes engage in combat with each other. It is necessary to fight and function well as a team to defeat the enemy heroes and emerge victorious from encounters. An encounter is called teamfight if the majority of heroes are involved in it. During the fight, the heroes have several ways to defeat the opposing team such as e.g. attacking them with the standard attack, using their hero's abilities or using items that can be obtained during the game. Many factors influence the outcome of a fight, ranging from ability and item builds over positioning and communication to raw player skill, but what ultimately kills a hero is the damage that was taken. Damage has three different types: physical, magical, and pure. Each of them affect the champions differently and add complexity to the game. Upon death a hero loses gold while the enemy heroes that contributed to the kill earn gold. Since heroes die on both sides, the criteria to win a teamfight is to earn more gold from it than the other team. Having a lead in gold usually increases the chance to win. Experience is another measure and correlates with Networth. They give a rough estimation on which team is currently winning.

3. Data and Tasks

While discussing teamfight analysis with experienced Dota2 players several questions arise. While questions like e.g., how much damage was dealt by each hero, or which abilities and items were used are already answered by teamfight summaries on a high level, they do not give insight on the progression of damage. Questions like whether there are sudden bursts, which hero was focused by whom and when, or whether someone switched targets, etc. cannot be answered by summaries. The answers to these questions would help to better determine if players made the right decisions.

We have identified several analysis tasks for exploratory analysis of Dota2 data. Following the recommendation by Mun-

zner [Mun15], we consider the tasks on three different levels, i.e., the match level, the teamfight level, and the individual hero level. We call the tasks that deal with match exploration high level tasks, tasks that deal with teamfight exploration are called medium level tasks, and tasks that deal with the exploration of an individual hero are low level tasks. The tasks can be summarized as follows:

- TH1** Explore impacts of teamfights in a match.
- TM1** Explore interactions between heroes in a teamfight.
- TM2** Distinguish interactions by damage type (physical, magical, pure) and source (standard attack, abilities, items).
- TM3** Explore temporal evolution of teamfight interaction network.
- TL1** Explore temporal evolution of a hero's damage during a teamfight.
- TL2** Explore order of a hero's actions (usage of abilities and items during a teamfight).

Thanks to the digital nature of ESports a lot of high quality data is available, because it can be treated as if it were collected from a lab-like environment [PBN*19]. Practically everything that happens during a match of Dota2 is logged and stored into a demo file that uses the Protobuf [pro] format. These so-called replays can be downloaded from platforms like opendota, which also provide information on e.g. the timeframes of teamfights in a match. By parsing a replay e.g. with the open source parser Clarity [cla] one can access match data in high granularity. The interaction data is obtained from the parse and are basically a collection of 'events'. Every event has a timestamp and a type. While there are many different types of events, Damage, Critical Damage, Healing, Ability, Item, and Death are those that interest us. These events can also have an attacker, a target, a source and value as well as damage type, if available. Attacker and target correspond to heroes, while source contains the info whether an ability, item or standard attack spawned the event. The value indicates how high the damage or healing dealt was and the damage type distinguishes between physical, magical, and pure damage.

4. Visualization Design

Based on the identified tasks we propose the Rumble Flow++ a novel web application for interactive exploration of Dota2 teamfights. The system consists of three views, the Networth and Experience Graph, the Rumble Flow, and the Cumulative Damage Curve, each of them answering specific tasks.

4.1. Networth and Experience Graph

The Networth and Experience Graph is a well known graph in the Dota2 community and shows the disparity of Networth and Experience values between the two teams over time. Users do not need to learn a new visualization concept to understand the presented information since it is already established and often used in real time when spectating a match. Roughly speaking, the graph shows which team currently has the upper hand. Climbing slopes indicate that the Radiant team gains momentum, falling slopes indicate the Dire does. Though it is not a requirement, the team with the lead usually wins the game. Opendota offers selection of a teamfight by showing a timeline and indicating fights at the corresponding times

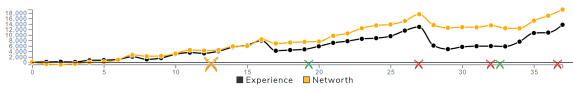


Figure 2: Example of a Network and Experience Graph. The teamfights are indicated with crossed swords on the horizontal axis. Especially after the third and fifth teamfight the slopes of the curves changed dramatically.

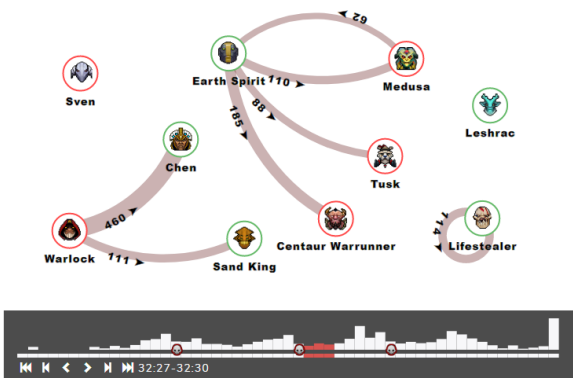


Figure 3: The Dota2 Rumble Flow showing temporally isolated exchanges of blows between heroes. The links indicate the damage amounts that were dealt in the selected timeframe. The timeframe is shown at the bottom as well as the damage barchart and death indicators (skull icons).

with crossed swords (see Figure 1). The indicators are color coded according to the team that won the fight i.e. red swords mean Dire won the fight, green swords mean Radiant won it. Yellow swords indicate the selected teamfight that is currently viewed. By combining this concept with the Network and Experience Graph, changes in the progressions and slopes can be identified as required by **TM1**. This deliberately is used for navigation of teamfights in a match inside the application (see Figure 2).

4.2. Dota2 Rumble Flow

To answer medium level tasks we created the Dota2 Rumble Flow, a node link diagram with weighted edges, based on dynamic graphs [Lan17]. The nodes of the graph correspond to heroes, the links to damage or healing events. These events have an Attacker and a Target, therefore edges indicate interactions between heroes as required by **TM1**. The links are weighted with the value of the corresponding event, while the label contains the exact amount as well as the directional information of a link. To distinguish between the teams, the borders of the nodes are color coded consistently with Dota2’s color scheme of Dire (red) and Radiant (green). Since a regular Dota2 match is always played with ten heroes, there are exactly ten nodes, incidentally keeping the graph clear and clutter free. A filter next to the visualization enables the user to show or hide certain interactions as intended by **TM2**. At the bottom of the Rumble Flow, the time controls are located. They enable the user to walk through the fight bit by bit and to look at the progres-

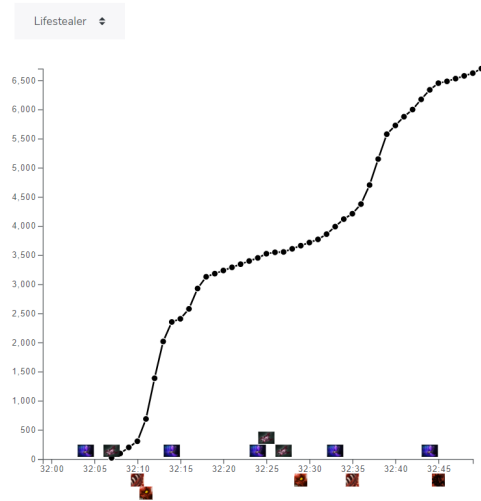


Figure 4: The Cumulative Damage curve for a single hero in a teamfight. The icons above the x-axis depict item usages, those below show casted abilities. While steep segments correspond mostly to damage dealt to enemy heroes, the flat parts in the curve show self damage caused by an item (see second icon from the left).

sion of a fight (**TM3**). With default options of one, three and ten seconds, timeframes can be selected in varying granularity. Aside from navigation purposes, this helps to identify hero focus and target switches, but also e.g. the moments when the heroes joined the fight. The busiest parts of a teamfight can easily be found by looking at the barchart above the timeline, which is based on aggregates of damage values for every second. Additional skull icons indicate hero deaths, which also help to navigate through interesting parts of the fight. The Rumble Flow in Figure 3 shows an example of a teamfight. For the shown timeframe, the main fight was between Earth Spirit, Medusa, Tusk and Centaur Warrunner, but there is an isolated scuffle that involves Warlock, Chen and Sand King.

4.3. Cumulative Damage Curve

In order to answer low level tasks another visualization has been designed. As its name suggests, the Cumulative Damage Curve shows the cumulative damage based on damage events of the selected hero over time, solving **TL1**. Since it is cumulative it is strictly monotonically increasing and holds valuable information in the slope. A steep slope indicates that a high amount of damage was dealt by the hero while a gentle slope indicates that a low amount was dealt. Even though the slopes are always in relation to the total damage the selected hero dealt in the fight, damage bursts can be easily spotted. Hovering over the curve shows the exact values and gives additional information on Targets and Sources of events i.e. attacks. Along the x-axis ability and item usages are indicated. This helps in the understanding of damage bursts and their sources and enhances the Cumulative Damage Curve as well as the Rumble Flow. By showing item usages slightly above the x-axis and ability casts below, it is easy to distinguish between the two sources. Ability or Item indicators that are in close proximity to their predecessor are

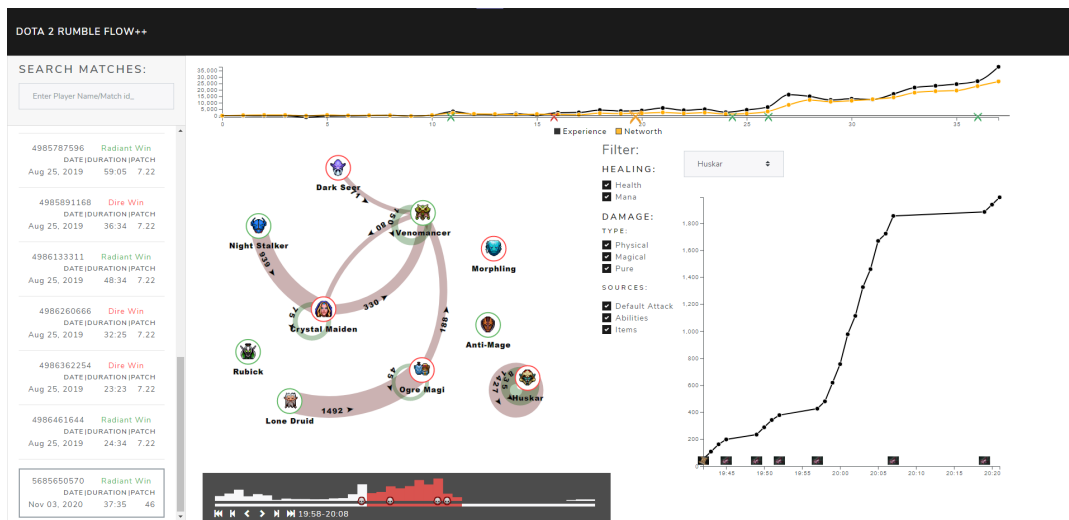


Figure 5: The application interface featuring three visualizations. *Above:* The Network and Experience Graph with the fifth teamfight being the selected one (yellow swords), *Left:* The Dota2 Rumble Flow showing interactions between heroes in the selected timeframe, *Right:* The Cumulative Damage Curve for the hero Morphling with ability and item usage along the x-axis. A skull symbol indicates the hero's death.

offset in height to avoid overlaps. Showing when and therefore in which order abilities and items were used solves **TL2**. Additionally a skull icon is displayed directly on the x-axis if the selected hero died during a teamfight. In Figure 4 the Cumulative Damage Curve of the hero Lifestealer is shown for a selected teamfight. The steep segments especially after the first two ability casts (see icons below the x-axis) indicate that Lifestealer dealt damage to other heroes, while the dense points along the curve show only damage that an item applies to Lifestealer when he uses it.

5. Evaluation

In order to evaluate the Rumble Flow we conducted an interview based user study with five participants. Since the Rumble Flow is mostly targeted towards players, all of them have played the game before, but the level of expertise varied between one beginner who is very new to the game, to an expert within the Divine rank with the other participants in between [ran]. We asked them about their usual behavior when they analyse teamfights and which platforms they use. Aside from the beginner, everyone used third party platforms like opendota before to gain insights into their previous played matches. These players also used to watch their replays in the past to look for certain situations and analyse them in greater detail, which are often teamfights. The most important aspects they look out for are who participates in the teamfight, hero positioning, when someone joined or abandoned the fight, who focused whom and item and ability usage. The participants were given several tasks to solve with the Rumble Flow as well as the opendota teamfight summary. Though five teamfights and two matches were used in the study, we want to emphasize the following scenario. Looking at an opendota teamfight summary which can be seen in Figure 1, we asked which heroes participated in the fight and which had the most impact. All five users answered, that nine heroes participated and Huskar had the most impact based on hero damage and healing

dealt. Exploring the same teamfight with the Rumble Flow, yielded different results. A selected timeframe of ten seconds is shown in Figure 5 The users answered, that only eight heroes participated, because Huskar only dealt damage and healing to himself. All five stated, that the summary is misleading because Huskar's actions were not related to the actual fight. Even more so, he was perceived as the hero with the most impact, though he did not even partake in the fight. This shows that context is important when looking at a hero's actions, which is not provided by high level summaries, but can be provided by the Rumble Flow.

6. Conclusion

The Rumble Flow++ is a novel web application that supports interactive exploration of Dota2 teamfights. It features three linked views to answer tasks on a high, medium, and low level. In contrast to conventional teamfight summaries the Rumble Flow++ provides more context and insight into the progression of a teamfight and its participants. While it uses concepts that are already established in the Dota2 community, players that are more familiar and experienced with the game will profit more from the Rumble Flow++ as a new teamfight exploration tool than beginners. Aside from improving the current controls, the most desired additions that were mentioned during the user study are information on the positioning of heroes, and more information on ability and item usage. But to bring the Rumble Flow++ to the next level, our future work includes teamfight analysis by machine learning to add suggestions and assessments to a player's decisions and interactions.

7. Acknowledgements

VRVis is funded by BMK, BMDW, Styria, SFG, Tyrol and Vienna Business Agency in the scope of COMET - Competence Centers for Excellent Technologies (879730) which is managed by FFG.

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