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Death Prediction in Dota 2: A Guide to In-Game Forecasting and its Value for Players, Broadcasters, and Spectators

Introduction

Esports games are played by millions of people around the world and generate vast amounts of telemetry data. Using this data to predict the outcome of matches has received considerable attention however micro-predictions, predicting events inside a match, remain a largely unexplored territory.

Micro-predictions are of continuing interest to both esports commentators and spectators because they provide the ability to quickly change the spotlight and observe events that might otherwise be missed. Esports games are complex and fast-paced; the balance of a game can change within seconds and it is easy for commentators and viewers to miss a key event.

To date, only one previous study has focused on in-game forecasting, with mixed success, and no existing work has focused on professional/semi-professional levels or predicted player hero deaths.

In 2019 we undertook a large-scale study of micro-predictions in Dota 2, one of the most played esports titles in the world. As part of this study we presented a system that provides accurate player death prediction within a five-second window.

The here and now: Existing in-game forecasting

A fundamental challenge of esports is making matches comprehensible and enjoyable for audiences. The nature of games such as Dota 2 can pose a challenge to spectators trying to keep track of the action. Gameplay is deeply strategic and information can be hidden.

Taking place in a virtual battle arena, Dota 2 games consist of two teams of five players. Each player selects one of many unique 'hero' characters to play. With each team's ultimate aim to destroy the opposing team's base, players must generate resources via fights against the rival team to progress through hero levels and become more powerful.

In Dota 2, a player character being killed by the opposing team is a key event and during a game players must closely monitor their hero's health status.

A death event is important for broadcasters' commentaries, spectators' understanding of the game state and players' tactics and analyses. However due to the complex nature of the gameplay, it can be easy to miss a player character death event, or indeed an event leading up to the occasion.

Academic research in the field of micro-predictions remains largely unexplored however player death events are an important part of the game narrative and micro-predictions have a critical role to play in making matches comprehensible to spectators.

Previous work by Cleghern et al. is the most closely related to our study. Cleghern's model predicted hero death in Dota 2 using data about health changes to predict when a player character will die. The model has poor performance however when it does predict health change points. The dataset used in Cleghern's study comprises 542 matches and it is not known if the matches are professional or amateur.

Our work trained a model that can reliably predict a death event with a high degree of accuracy within a 5-second window. This window provides plenty of time for commentators to direct their focus before a kill occurs in the game. The model has also learned inherent properties of features that constitute kills and in certain situations can predict a character death approximately twenty seconds before the event occurs.

The future: Enhancing experiences across esports

Player character death prediction is complex and requires careful investigation however it presents largely unexplored opportunities for improving spectator and player experiences.

Our study analysed a much larger set of in-game features compared to previous esports research and demonstrated that a hero's health variable does not correlate with that character's likelihood of death.

Whilst data about health changes might seem like an obvious indicator of a hero's likelihood to die, some characters have abilities that allow them to heal themselves or their team-mates. Heroes can also purchase in-game items that allow them to heal or teleport away from danger.

We found that metrics including time, the current state of the player, activatable items, hero abilities, hero position, distance to closest alive enemy and ally tower, and visibility history were the most important factors contributing to a player character's death.

Our analysis involved the collection of public Dota 2 replay files provided by Valve from 5,000 professional (major tournaments) and 5,000 semi-professional (minor tournaments and leagues). Accounting for errors in downloaded game data, this resulted in a total usable dataset of 9,883 matches.

Using the data, we trained a deep learning model that can accurately predict the death-state of every player within a live or recorded game of Dota 2. The model learned inherent properties of features that constitute kills and can predict the death of professional Dota 2 player characters with a high degree of accuracy, within a five second window.

Understanding the likelihood of player character death in the near future would enable commentators to simplify complex build ups to when a player dies. Live broadcasts would benefit from feeding this information back to the audience, alongside automated camera movement or observer tools to direct the focus when these predictions occur to a high enough degree of accuracy.

This could potentially make the commentators' job and the spectators' experience a far smoother process. It could also integrate into the training schedules of professional esports players, forming part of post-game analysis and helping players to determine what tactics they should employ.

Summary and next steps

We believe that our research introduces the first step towards the larger challenge of micro-predictions in esports.

Esports analytics is complex and requires careful consideration of the data and models used. Frequently no one technique excels however, we believe that our work will assist future studies targeting micro predictions in esports.

Our study explores the application of deep learning models to Dota 2 at a micro level and introduces a novel prediction framework using a shared memory neural network.

The model enables real-time micro predictions of kills in Dota 2, one of the most played esports titles in the world, within a five second window. This gives commentators and viewers time to move their attention to these key events, and provides players with enhanced data for post-match analysis.

The focus of this study was on player death prediction, however we could also use micro prediction models to draw attention to other in-game events. Tower destruction, Roshan (a neutral character not controlled by any player) kills, or a player barely escaping death can be just as interesting and exciting as when a player character dies.

Link to academic paper > <https://arxiv.org/pdf/1906.03939.pdf>