Modeling Wave Management in MOBA Games

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The Multiplayer Online Battle Arena (MOBA) genre of online video games is a relatively recent, albeit incredibly popular phenomena. These are team based strategy games in which players control characters inside of an arena, and make a series of strategic moves in order to gain opponent territory and ultimately capture the opponent base. Due to the nature of these games, they are the current most popular genre of "eSport" games; in 2018 the League of Legends World Championship had approximately 99.6 million unique viewers, with a peak concurrent view count of 44 million. Despite all of the above, there has been very small amounts of research into the different aspects of the game, and in particular, optimal strategy for professional play[1]

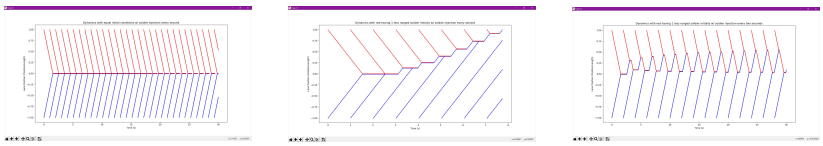

Figure 1: Different plots over time for various initial conditions of soldiers starting from base. The leftmost graph represents a standard control experiment in which both teams are equal. The middle graph is the behavior when 1 singular ranged soldier is removed from the red initial conditions. The right graph is the same initial conditions as the middle plot, but with soldier injection occurring half as often.

For the purposes of this problem I will be explicitly referring to the most popular MOBA, however this mechanic holds true in other MOBAs as well. One of the most important skills for a professional player to have is called "wave management". When properly executed, immense pressure can be placed on the opposition team which allows for large playmaking opportunities. This comes from the following rules:

At fixed time intervals, a group of AI soldiers (known as minions or creeps) will march from each teams' base in a line until they encounter the soldiers from

[1] Marçal Mora-Cantallops and Miguel-Ángel Sicilia. "MOBA games: A literature review". In: *Entertainment Computing* 26 (2018), pp. 128–138. ISSN: 1875-9521. DOI: https://doi.org/10.1016/j.entcom.2018.02.005. URL: http://www.sciencedirect.com/science/article/pii/S1875952117300149.

the opponent team. These soldiers will engage in combat until they, or the other group are defeated, in which they will continue to march in a line towards the enemy base.

In an ideal model, these soldiers meet in the middle between each base and simultaneously defeat each other which leads to a equal stalemate in the center. However, small variations of the conditions can drastically change the behavior of the simulation, as shown in the figures.

Currently all wave management mechanics are heuristic "eye-balling" it[2]. The question is given some initial conditions, is it possible to accurately predict the dynamics of the soldier movement at some time t in the future?

[2]Mobalytics. *League of Legends: Ultimate Wave Management Guide*. Nov. 2019. URL: https://mobalytics.gg/blog/wave-management/.