Utility Model for Battle Royale Games

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Spring 2020

Introduction

Battle Royale games are the latest trend in online videogames where each opponent placed in a free-for-all arena and the last player standing is deemed the winner. While placing well (i.e. being one of the last players alive) gives a player utility, so does getting eliminations (i.e. beating other players in firefights). The goal of this response is to make a simple model for utility that illustrates the trade-offs between earning more eliminations and placing higher in a match.

Fighting

Since each player begins the game with the same items (i.e. equal health, armor, and weapons), it is assumed assume that a player's base probability of winning a one on one fight is correlated with their skill. One way to calculate this probability is to use a player's Kill-Death Ratio (R). Since each kill represents a fight they won, and each death represents a fight they lost we estimate their probability of winning a fight $w = \frac{R}{R+1}$.

Expected Placement and Eliminations

Given the number of fights a player plans on engaging in during a match we can calculate their expected placement for the match. By assuming a uniform distribution of fights across the length of a match and that other players are being eliminated at a relatively constant rate, we express a given players expected placement as

$$p(x) = w^x + \sum_{i=1}^{x-1} \frac{i}{x} \cdot w^i \cdot (1 - w)$$

where x is the number of fights they plan on starting with $p(x) = 1$ meaning first place and $p(x) = 0$ meaning last. Similarly we can model the expected number of kills as

$$k(x) = w^x + \sum_{i=1}^{x-1} i \cdot w^i \cdot (1 - w)$$

Utility Model

Since both functions individually have a positive correlation with utility, we can combine them into the general utility function

$$u(x) = \frac{1}{2}p(x)^2 + \frac{1}{2}k(x)^2$$

which is expresses total utility as a function of how many fights the player plans on engaging in. This utility function is subject to the diminishing marginal utility and has a maximum utility value which implies the existence of an optimal number of fights to pick. This simple model overlooks other potential important aspects of Battle Royale games such as looting, building, the Gulag, etc; however I believe that it successfully highlights the trade-off relationship between eliminations and placement.

"All models are wrong, but some are useful" - George E.P. Box