An Analysis of DOTA2 Using Game Refinement Measure

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Abstract. DotA is one of the most attractive and influential MOBA games, which has been popular in many countries for over 10 years. It was designed for fun at first, however, after the emerge of DOTA2 it soon became the highest prize e-sports game. This paper analyzes the evolutionary changes of the DOTA2. The game refinement measure is employed for the assessment of game sophistication of DOTA2 series. The analyzing results show that the rules of DOTA2 have regularly been changed in its history to maintain an appropriate range of game refinement. We clearly see two directions during the evolutionary changes which are the skillfulness and popularity. Thus, the analysis makes it possible to overview these evolutionary changes of DOTA2 and find some drawbacks to be improved.

Keywords: MOBA game · Game refinement theory · Evolutionary changes · DOTA2

1 Introduction

The rules of sports and mind sports have been elaborated in its long history to be more sophisticated and fascinating. It is interesting to know their characteristics and evolutionary changes using a measurement of game sophistication, which have recently been reported. For example, in the domain of sports, soccer and basketball [1], volleyball [2], table tennis and badminton [3], baseball [4] and boxing [5] have their own unique histories of the rules change to be more sophisticated. In the domain of mind sports, chess [6], Mah Jong [7] and shogi [8] have also a similar way. These reports indicate that the rules of sports and mind sports have been changed to be more sophisticated, but at the comfortable level. This may relate to the flow theory [9]. DOTA2 is a free-to-play MOBA video game developed and published by Valve Corporation. The game was released for Microsoft Windows, OS X, and Linux in July 2013, following a Windows-only public beta testing phase that began in 2011. DOTA2 is one of the most actively

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played games on Steam, with maximum peaks of over a million concurrent players. The game follows the same paradigm of a similar game, which was inspired from the original DotA map. Both games follow the same idea of leveling of a character, gaining items and hunting down non-player controlled monsters and player-controlled heroes with the ultimate goal of destroying the opponent's base. A match ends when one side breaches the opponent's stronghold and destroys the Ancient therein. In this study we focus mainly on the domain of e-sports and have chosen DOTA2 as a benchmark. One of the big issues in our society is the online gaming addiction on youth since many teenagers spend more than 15 h a day online games [10]. However, little is known about the degree of game sophistication of e-sports. Therefore, we investigate the evolutionary changes of DOTA2 with the following two research questions:

– What is the degree of game sophistication of DOTA2 series?
– What is the most remarkable change in the history of DOTA2 series?

The structure of this paper is as follows. Section 2 presents our assessment methodology with a focus on game refinement theory. In Sect. 3 the game refinement theory is applied to DOTA2 for its assessment and the results are discussed. Finally, concluding remarks are given in Sect. 4.

2   Assessment Methodology

DOTA2 is a game with complex game information, so we need to consider the essential game progress for this game. During the in-game period, there are totally 3 game information progresses. One is the gold progress, another two are the experience progress and killing progress. Thus, we need to figure out an appropriate game progress model of DOTA2 to apply game refinement theory. Even though DOTA2 is not a score limited game, we can still clearly find a conspicuous scoring board of killing at the top of the interface. This is the only scoring information that two teams both know during the in-game period and they do not know the exact gold and experience the opponent achieved. The "game progress" is twofold [11]. One is game speed or scoring rate, while another one is game information progress with a focus on the game outcome. In sports such as soccer and basketball, the scoring rate is calculated by two factors: (1) the goal, i.e., total score and (2) time or steps to achieve the goal. Thus, the game speed is given by the average number of successful shoots divided by the average number of shoot attempts. On the other hand, "game information progress" presents how certain is the result of the game in a certain time or steps. Let K and T be the average number of successful killings and the average number of attempt per game, respectively. If one knows the game information progress, for example after the game, the game progress $x(t)$ will be given as a linear function of time t with $0 \leq t \leq T$ and $0 \leq x(t) \leq K$, as shown in Eq. (1).

$$x(t) = \frac{K}{T}\, t \qquad (1)$$

However, the game information progress given by Eq. (1) is usually unknown during the in-game period. Hence, the game information progress is reasonably assumed to be exponential or so. This is because the game outcome is uncertain until the very end of game in many games. Hence, a realistic model of game information progress is given by Eq. (2).

$$x(t) = K(\frac{t}{T})^n \qquad (2)$$

Here n stands for a constant parameter which is given based on the perspective of an observer in the game under consideration. Thus, the acceleration of game information progress is obtained by deriving Eq. (2) twice. Solving it at the end of the game ($t = T$), the equation becomes

$$x''(T) = \frac{Kn(n-1)}{T^n}t^{n-2} = \frac{K}{T^2}n(n-1)$$

It is assumed in the current model that the game information progress in any type of games is happening in our minds. We do not know yet about the physics in our minds, but it is likely that the acceleration of information progress is related to the force in mind. Hence, it is reasonably expected that the larger the value $\frac{K}{T^2}$ is is, the more the game becomes exciting due to the uncertainty of game outcome. Thus, we apply its root square $\frac{\sqrt{K}}{T}$, as a game refinement measure (say GR). We show, in Table 1, several sophisticated games including chess and Go from boardgames, basketball and soccer from sports and DotA from MOBA games [12]. We see that sophisticated games have a similar GR value which we recognize a zone value between 0.07 and 0.08. This indicates the same or similar degree of game sophistication where players may feel the same level of engagement or excitement regardless of different type of games.

Table 1. Measures of game refinement for various type of games

Game	G	T	GR
Chess [6]	35	80	0.074
Go [6]	250	208	0.076
Basketball [3]	36.38	82.01	0.073
Soccer [3]	2.64	22	0.073
Badminton [3]	46.34	79.34	0.086
Table Tennis [3]	54.86	96.47	0.077
DotA 6.80 [12]	68.6	106.2	0.078

3   Analysis and Discussion

This section presents the analyzing results of DOTA2 series using the game refinement measure and discusses its rule changes with a focus on prize in a championship.

3.1   Analyzing Results

To obtain the latest GR of DOTA2 series, we collect the data from the historical TI championships. For this purpose, we download all the replay of the final to calculate its GR values. We show, in Table 2, GR value of each TI championship, together with prize money compared [13]. Table 2 and Fig. 1 shows that from 2011 to 2014 GR value decreases. The rules of DOTA2 have been changed for that period to be more competitive as the prize became higher. However, such rule changes (decreasing of GR value) made DOTA2 boring for the viewers.[1] On the other hand, the designer of DOTA2 has attempted many rule changes with expectation that DOTA2 would have more uncertainty while adding new items and incorporating the unexpected factors which mean that a lower rating team would win against a higher rating team with higher probability than before. Thus, after 2014 until now, GR values are increasing.

Table 2. Measures of game refinement for DOTA2 series and prize at TI championship

Year	Championship	K	T	GR	Prize (US dollars)
2011	TI1	51.3	93.0	0.077	1,600,000
2012	TI2	32.5	76.3	0.075	1,600,000
2013	TI3	36.6	81.8	0.074	2,874,380
2014	TI4	30.0	77.3	0.071	10,925,709
2015	TI5	39.8	89.4	0.074	18,429,613
2016	TI6	54.0	94.3	0.078	20,746,930

3.2   Rule Changes in 2011–2013: Towards More Skillful

The TI championship series is the most significant and profitable annual event for DOTA2 since 2011 [14]. The game designer has attempted to modify the rules as described in Table 2. In 2011, Smoke was introduced for DOTA2 Ver. 6.70. The Smoke of Deceit is an item purchasable at the Main Shop, under Consumables. It turns the user and nearby ally heroes invisible, letting them slip by wards and creeps undetected. Upon activation, the user and all nearby allied player-controlled units gain invisibility and bonus movement speed for a brief time. Thus, many new tactics were explored after the emerge of Smoke items. Then the team behavior became conservative after the only three Smoke items were included during the in-game period. In 2012 the nerfed numerous heroes in Ver. 6.74 has established the foundation for the TI championship to enhance the game rigorism since DOTA2 has become a game to be played not only for fun but also for prize seriously. The appearance of the new captain mode in 2013 of Ver. 6.79 has contributed to maintain the fairness at the initial with the

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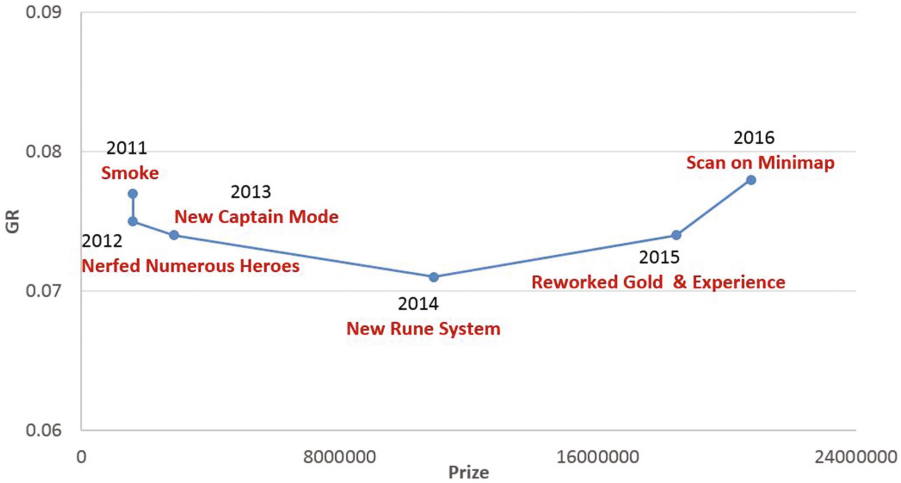[1] Actually many people complained about the conservative game progress.

Fig. 1. GR values and prize pool of DOTA2 in 2011–2016

expectation that the rule of ban and pick system greatly would influence the game result. For both teams, it is no longer easy to choose an unbalanced hero and relatively hard to successfully kill the enemy as before. For the period 2011–2013, the average number of killing, denoted as K in the game progress model, has decreased year by year. This implies that GR value has become lower. As a result DOTA2 has become more skillful and competitive. Note that DOTA2 mainly focused on hero development and less gank or battle.

3.3   Rule Changes in 2014–2016: Towards More Popular

A highly skill-based game would not become popular since skill itself is unfriendly to the beginners. In 2014 the new rune system in Ver. 6.82 came out and added bounty rune. Runes are special boosters that spawn on the game map. Picking up a non-bounty rune grants the player a powerful effect for a short time. Runes spawn at two points in the river. The emerge of bounty rune makes the supporter or carry get money easier and the player can purchase the items earlier than before. This also accelerates the game progress. In 2015 the game designer reworked the gold and experience mechanism in Ver. 6.84. The new mechanism encouraged two teams to take part in more battle activities as they can get more gold and experience than before. The new rules focus more on gank and push issue instead of hero development. Another interesting mechanism of scan appeared in 2016 of Ver. 6.87 and we can comprehend this mechanism as a strategic skill for both teams. Players can use the Scan ability on top of the minimap UI to detect any enemy heroes in an area. This mechanism greatly made the game more exciting and added an extra level of uncertainty as the players do not know the exact number of enemies. To summarize all these new mechanisms accelerated the game progress and enhanced the uncertainty during the in-game

period. The new mechanism offers more uncertainty for both teams to win or make mistake in the game. Then, the game has become more uncertain until the very end of the game. Thus, we see that GR value has increased after 2014 and it is supposed that DOTA2 will become more and more popular in the future. We see that the balance between skillfulness and popularity is so important for the survival of a game.

3.4 High Prize

As we have mentioned above, DOTA2 has over one million concurrent players while being the most profitable sports in the world. It seems that DotA was first designed only for fun, however, with the contributions of sponsors and game designer, DOTA2 has become a main trend of e-sports. The dynamic changes of each version and high prize made DOTA2 the most successful and profitable e-sports even in its short history. Now DOTA2 has lack of popularity as this game is still unfriendly to the novice players and has a relatively complex game information to learn, as there are totally over 110 heroes and 150 items. However, compared with other sports, we see that DOTA2 is now at the peak, as shown in Table 3 [15].

Table 3. Tournament prize in sports, mind sports and e-sports compared

Event	Sports	Prize (US dollars)	1st prize
Australia Open	Tennis	35,530,000	1,040,000
NBA	Basketball	14,000,000	4,100,000
FIFA Club World Cup	Soccer	28,000,000	5,490,000
Ing Cup	Go	650,000	400,000
S6	League of Legends	5,070,000	2,130,000
TI 6	DOTA2	20,746,930	9,140,000

4 Concluding Remarks

In this study we evaluated the DOTA2 series using the game refinement measurement. The results indicate that DOTA2 has a similar zone value with sophisticated sports and boardgames. In addition, DOTA2 championship of every year during 2011–2016 was analyzed. The results show that the game refinement value has stayed within 0.071-0.077, which is slightly lower than DotA. The prize of the championship has strongly influenced the development of DOTA2. Higher prize enforced the players to be more conservative and the game refinement value became lower which implies that DOTA2 became more skillful. However, such a direction of game evolution was not accepted in DOTA2 community due to the lack of entertainment. Later, the direction of DOTA2 evolution was shifted to be more popular while taking stochastic elements into consideration. Thus we see that a good balance between skillfulness and popularity is essential to survive.

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