Title	
Author(s)	Xiong, Shuo
Citation	
Issue Date	2017-09
Type	Thesis or Dissertation
Text version	ETD
URL	http://hdl.handle.net/10119/14824
Rights	
Description	Supervisor:　　　　　　,　　　　　　　,

Japan Advanced Institute of Science and Technology

Abstract

Human cannot live without game in this era. A lot of researchers and related workers begin to find a way to make a game more interesting and exciting. In addition a game as Ninth Art has the special humanistic value. With such backgrounds 'game informatics' has been established as a new research area in the field of information and computer science. This thesis focuses on the game refinement theory application and its development. The present contributions can be divided into two parts: natural science and social science. Chapter 2 to Chapter 7 discuss mainly from the viewpoint of the natural science, whereas Chapter 8 and Chapter 9 are studied from the perspective of the social science.

Chapter 1 introduces the background of the study in this thesis with the following research questions: what is game? Why do people need game? And how does a game evolve from ancient times to the current age? Focusing on the history of chess and evolutionary process of video games, we notice that in order to win a game, human created a mathematical branch subject called 'game theory'. However, game theory mainly focuses on solving problems or how to win the game, and it does not show any method for game designers. From the game designer's point of view, Iida et al. [66] [65] proposed a new approach called game refinement theory.

Chapter 2 presents the mathematical model of game refinement. Game refinement idea is a unique theory that focuses on the uncertainty of game outcome. A game refinement measure was derived from a logistic model of game information progress and has been applied in the domain of boardgames with promising results. The following work was to apply the game refinement theory in the domain of different type of games which are continuous movement games such as Pokemon, soccer, crane game and score limited sports to verify if the game refinement idea is useful and correct.

Chapter 3 employs the game refinement theory and its measurement to analyze a new type of sports called electronic sports or e-sports such as StarCraft II and MOBA games. The present challenge is to apply the game refinement theory in the domain of RTS (real time strategy games like StarCraft II), MOBA (multi-player online battle arena

like DotA). To do so, we use StarCraft II as a testbed and introduce a concept of strategy tree in order to construct a game tree of a RTS game. Then, game refinement values are calculated and compared with other type of games. It is found that StarCraft II has a zone value of game refinement. This chapter also focuses on the game refinement theory and its application to two MOBA games "Heroes of the Storm" (HotS) and DotA. Furthermore, we evaluate the measurement for different maps of HotS and different version of DotA. Experimental results show that a game refinement value of HotS is located somewhere between 0.08 and 0.1, whereas the value of DotA is located somewhere between 0.07 and 0.08 for which previous works have confirmed.

Chapter 4 proposes a novel method to tune the entertainment impact of Role-playing-game (RPG). Game refinement measure is employed to assess the degree of game sophistication or player experience like excitement. RPG is a type of games, in which players assume the role of characters in a fictional setting, along with the game process such as kill monster, and the character will level up and get new ability. However, in traditional RPGs, players may feel unchallenged as the adventure becomes predictable. The main problem has been found to be in one of the three game components: level-up system, money and weapon system, and battle system. We utilize the game refinement theory and a mathematical model to design a reliable level up system in RPG to make players feel more exciting and adventurous. The game refinement theory has provided a new insight into the two games selected for this study and suggested a countermeasure for weapon system and battle system. The findings show that scientific method used by utilizing the game refinement theory can resolve issues in the fields of game technology.

Chapter 5 focuses on a paradox of the game refinement theory and proposes a new theory called unexpectedness theory. A mathematical model of game refinement is constructed based on uncertainty of game outcome. A game refinement measure is derived from the game information progress model. This model has been shown to be useful in measuring the entertainment element in the domains such as boardgames and sports games. However, game refinement theory has not been able to reasonably explain about how the popularity of a game can be attached to the game refinement value. This chapter introduces another notion in the study of game entertainment, so-called "unexpectedness". Unexpectedness is an important entertainment aspect of game playing, which

makes it possible to extend the early model of game refinement. The extended model enables to reasonably explain the sophistication-popularity paradox of game refinement theory, i.e., on why some games with similar sophistication level would have different population of fans and players. In order to tackle the paradox, we revisited the Newton's classical mechanics to excavate more physical meaning in games and expand a new mathematical model to represent "unexpectedness " and explain the paradox phenomena. Two applications are presented to demonstrate how this model can be effectively used to measure the part that previously has not been able to explain.

Chapter 6 analyzes the unexpectedness phenomenon in the domain of sports games. Elo-rating system has been widely used to predict the outcomes in various domains such as boardgames and sports games. However, Fdration Internationale de Football Association (FIFA) like other associations use their own ranking system with certain purposes other than ranking accuracy only. This chapter studies four different ranking methods: Elo-rating system, Betting Odds, FIFA rating based on Elo style and FIFA rating based on Davidson Wang's method, with which 36 round-robin matches of UEFA Euro 2016 are analyzed. It then explores entertainment aspects based on uncertainty of outcome prediction that may have occurred by ranking methods. Moreover, the trade-off between the ranking accuracy and popularity promotion is investigated.

Chapter 7 explores possible interpretations for game refinement measure which has been successfully used to quantify the game sophistication of various types of games such as boardgames and sports. It first presents a brief sketch of game refinement theory with a focus on its early works with boardgames, expansion into continuous movement games such as sports, and a bridge between sports and boardgames. It then highlights the bridging idea while considering possible interpretations for game refinement measure, and the meaning of game refinement measure is discussed with a focus on the skill and chance aspects in game playing. Thus, it enables to have a new perspective of game refinement theory. Moreover, an example of interpretation for game refinement measure from boardgames and continuous movement games such as MOBA game is shown. The interpretation is well fitting to our intuition as game players and spectators.

Chapter 8 considers another train of thought on how to design a game from the viewpoint of social science. It analyzes the cross media impact using "Journey to the

West", which is a Chinese novel published in the 16th century during the Ming dynasty and attributed to Wu Cheng'en, being one of the Four Great Classical Novels of Chinese literature. In the past 400 years, "Journey to the West" had been recomposed to many different media styles such as Novel, xylograph, comic, animation, drama, Peking opera and game. This chapter explores the reason why "Journey to the West" can be so popular in eastern Asia and has been developed into different media forms, then draws the time line of cross media evolution and the development process. From the case study using "Journey to the West", we learn how to spread and converge culture what can help game designers understand how to choose their topics, then create a wonderful cross media successfully.

Chapter 9 focuses on the research related with China and Japan game market. In ancient times, classical boardgames have been developed and dispersed throughout the entire world. However, in recent years, the game industry is developing fast in many countries. Japanese games and Chinese games all have similar opportunities and problems in the modern context. The most serious problem both facing is "sakoku which means, in Japanese and Chinese word, seclusion from the outside world. Although the effects of sakoku are very far-reaching, this chapter examines the effects of seclusion from the outside world in the context of game development. The Chinese game industry is still in the development period. If the sakoku problem is not yet solved, the Japanese game industry will decline and fall behind that of the West. For their part, Chinese game developers who fail to address gamers beyond their borders stand to lose the best chance to step into the successful development of the gaming future.

Chapter 10 gives the conclusion in which research questions and problem statement in this thesis are answered, and suggests several possible future works.

Keyword: Game refinement theory, Game design, Mathematical model of game, Cross media and IP, Game market.