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The evaluation of massive multiplayer online role-playing games based on expanded dependency graph

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ARTICLE INFO

Article history:

Received 16 July 2009

Received in revised form 2 August 2012

Accepted 3 March 2014

Available online xxxx

Keywords:

Expanded dependency graph

Measure chart

MMORPG

Multi-criteria decision

ABSTRACT

Evaluating massive multiplayer online role-playing game (MMORPG) before purchasing and operating them is of paramount importance to earn high profits. Dependency graph (DG) is fit for modeling and analysis of the MMORPG as it is relatively easy to understand and conducive to the synthesis between different networks. However, the conventional DG cannot describe how or to what degree events depend on each other. Therefore, we propose an expanded dependency graph (EDG), where logic operations are introduced to describe how events depend on each other, and colored tokens are adopted to represent to what degree events depend on each other. Based on EDG, MMORPG can be evaluated in a quantitative manner using three measure indexes: complexity, sociality, and game balance. Furthermore, the measure chart is also adopted to standardize the three measure indexes and deal with the multi-criteria decision problem. The proposed method is tested with the real word data and experimental results indicate that our method shows competitive performance over other methods.

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1. Introduction

The massive multiplayer online role-playing games (MMORPGs), which allow on-line game users to assume a broad range of fantasy roles, interact with one another and even create their own virtual worlds, are one type of entertainment oriented and internet-based information technology.

Nowadays, popular MMORPGs have been a highly profitable e-commerce application [4]. By 2007, the value of global on-line game market has reached US\$ 5.5 billion, increased markedly from US\$ 670 million in 2002 [28]. Huge potential profit has driven the development of a large number of MMORPGs in each year. However, owing to design flaws, the majority of these MMORPGs are proven to be failure ones. As a result, much money is wasted on these undesirable MMORPGs. Since the unwelcome game will waste a lot of costs, while the popular game will bring high profits, evaluating MMORPGs before designing and operating them is an effective way to avoid risks. Nevertheless, studies on the evaluation of MMORPGs remain limited. In this case, we propose a MMORPG evaluation method based on the expanded dependency graph (EDG).

MMORPG is a very complex software system, elements of MMORPG are integrated and interacted, relationships among elements are multifarious and intricate, events among some elements may have an impact on other elements and their responses to these events may cause a storm of events. Therefore, to analyze and evaluate MMORPG, the most important thing is to model and describe them. Generally, there exist many event-based modeling approaches to analyze a complex system like MMORPG, for instance InWoLvE system [13], event graph [17], block structure [20], Petri Net (PN) [1], and Dependency

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Graph (DG) [2]. Among many approaches, DG is relatively easy to understand and conducive to the synthesis between different structures and is fit for modeling and analysis of MMORPG, while it is also a powerful modeling and evaluation technique for problems involving coordination in a variety of domains. For example, it has been successfully applied in predicting subsystem failures [26], proving termination of rewriting [3], modeling complex and application-specific interfaces [19], representing instruction set customization [14], etc.

Although the conventional DG can describe the cause–effect relationships of complex systems, it cannot describe how or to what degree events depend on each other. Therefore, we propose the expanded dependency graph (EDG), where logic operations are introduced to represent how events depend on each other, and colored tokens which indicate the possibilities of each event are adopted to indicate to what degree events depend on each other. Considering the complexity of MMORPG, such EDG is useful for describing and modeling its event storm and running mechanisms. In addition, based on EDG, the corresponding MMORPG can be evaluated in a quantitative manner from three aspects: complexity which shows the complexity of sights and happenings in the virtual world, sociality which reveals the interactivity of players in game, and game balance which demonstrates the balance of advantages and disadvantages of each kind of character in game.

However, the evaluation of MMORPG from these aspects is in the presence of multiple and conflicting criteria and is usually approached by the conventional multi-criteria decision making (MCDM) methods, for example decision tree, Analytic Hierarchy Process (AHP) method [23], and fuzzy method. Generally, the weight of each criterion in MCDM problem is often inaccurate and not completely sure, so adopting fuzzy method to solve MCDM is a hot topic of current studies. However, the fuzzy method standardizes the criterion weight with a fixed function, rather than adaptively standardize them according to the specific issues, and that affects the decision-making accuracy [9]. Therefore, we propose a measure chart method to overcome the deficiencies of the existing researches by adaptively generating criterion weights according to the training sample, which will be discussed in detailed in Section 4.

The rest of paper is organized as follows: Section 2 gives an overview of related works on event-based modeling methods for complex systems and MCDM. Section 3 describes MMORPG based on EDG. Section 4 offers the evaluation of MMORPG. In Section 5, experiments with real word data are made to demonstrate the workability of our proposed methods.

2. Previous works

2.1. Event-based modeling methods for complex systems

To describe the dynamic characteristic of complex systems, lots of events should be considered both expected and unexpected. All these events are correlated with each other to form a storm of events; some events have significant consequences, while others are less important. The critical problem lays in identification the significant events and their corresponding relationships. Many approaches can be provided for doing so, for instance Herbst and Karagiannis gave an overview of the algorithms that were implemented within the InWoLvE workflow mining system. Using InWoLvE, they created a stochastic activity graph from the example set and transformed this stochastic activity graph into a well-defined workflow model [13].

Liu et al. proposed a generic approach of business process simulation for operational decision support which included business processes modeling and workflow simulation. In their study, processes were modeled with event graphs through process mining from workflow logs that integrated comprehensive information about the control-flow, data and resource aspects of a business process. A case study of a credit card application was presented to illustrate the steps involved in constructing an event graph [17].

Schimm et al. proposed the algorithm to describe the relationship between the activities in selection, sequential, parallel and loop structures. The algorithm had the advantages of encapsulation and readability as it is based on the block structure. But it could only deal with the cycle of the obvious block structure and was unable to find complex loops, which caused this method could not accurately express the complex system [20].

PN is the most common one in system modeling tools, which can not only depict the structure of the system, but also describe the dynamic behavior of the system. Aalst proposed the α algorithm based on PN, the algorithm divided the activities in the system into four categories according to their timing relationship and then constructed the workflow model of the complex system [1].

Carmona proposed an algorithms for the derivation of a PN from the existing software system. The methods were grounded on the theory of regions, which mapped a model in the state-based domain (e.g., an automata) into a model in the event-based domain (e.g., a PN). The decomposition and projection techniques were introduced to alleviate the complexity of the region-based algorithms for PN discovery, thus extending the applicability of PN to handle large inputs [6].

Fang et al. proposed Discrete Particle Swarm Optimization (DPSO) to describe the complex business process. DPSO took into account the basic PN structure and the metrics of behavior conformance and avoided the blindness of building process model. Finally, a DPSO process mining plug-in was created and a number of event log was tested in the DPSO mining plug-in [11].

It is necessary to study the integration issues between the different structures of PN in order to describe the large-scale software systems. Not intuitive like the synthesis of the same structure PNs, the heterogeneous PNs are difficult to directly be combined together. The conversion algorithm should be considered in the process of their integration, while integration activities will cause some changes of the model properties and behaviors. Nowadays, there are lack of methods to judge

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