

Chapter 2

Dynamic Role Behavior for Managing Users Through A Networked Collaborative Monopoly Game Abstraction

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Abstract e-Technology has enabled users from remote locations to collaborate together virtually and involve in e-activities to reach their common goals. The virtual environment is commonly known as Networked Collaborative Virtual Environment. It is a challenge to manage these remote located users since they are diverse in term of language, culture, and skill. Most of the managements are performed by external entity such as administrator. As a result, the external handling is hardly matched or coped. Thus, this paper investigates the possibility of having a method called role behavior to manage users both internally and externally. The initial finding shows that roles are dynamic and their dynamic behaviors are further analyzed through a collaborative monopoly game. As a result, a set of role behaviors has been extracted from the game. Each behavior is analyzed and mapped to a real-life application as an abstraction of user management. Finally, a mathematical model has been proposed to represent a comprehensive collection of roles which has to be used in managing dynamic environment.

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2.1 Introduction

In networked collaborative virtual environments (NCVE), users work together from remote location. This is possible with the advance of e-Technology such as network communication (machine to machine), video, audio, and text communication (human to human). In such environment users are represented by digital elements such as avatars, texts, and graphic images. They might be from different organization or countries as such their ethnics, working culture, and skills are also different. In most cases, they do not have the opportunity to see each other in a face-to-face environment. Therefore, it is important to have an effective management system to manage these remote users through standard of principles, governing rules, and policies [1, 2].

Users in NCVE are dynamic, thus, role-based management has been identified as a suitable method to manage them. In such management, tasks for the collaborative works will first be identified and assigned to role. Then, access right to resources such as database and files are assigned to the role [3, 4]. For security purposes, only certain role has the permissions to access certain resources. The permissions are managed by role-based access control (RBAC) through policies [5]. The policies are a set of rules which specifies permission to resources. In other words, RBAC controls all the permission to resources as a means to protect resources [6]. RBAC also has to ensure that only qualified roles get access to permitted resources.

Moreover, it is essential for role to be managed and structured. The common organization structure for role is flat hierarchy, matrix, and peer-to-peer organization [7]. Only after the role organization structured has been form, qualified users can be searched and assigned to roles. Once assigned, users are accountable to the tasks and are granted with permission to the resources. Since the organization structure is independent of users, changes of users impose minimum impact to the roles and their structure. Hence, a vacant role can be replaced by simply searching a new qualified user.

From management perspective, role is defined as an abstract entity to establish communication, coordination, and cooperation among, tasks, users, and resources. It becomes the hub of management where its obligation is more than just an agent for assigning responsibility and permission to users. Essentially, a successful collaboration is highly determined by how well the role integrates the three main collaborative elements which are users, tasks, and resources. The elements have to be integrated in a right manner and at the right time. This is vital since users, tasks, and resources are dynamics where their states are unpredictable.

As a central of management, roles' behaviors must be identified to depict their full potentials. Thus, this paper has explored roles in NCVE to discover their behaviors. The exploration has identified a range of roles' behaviors which will be

utilized by controlling agent in managing users. A collaborative monopoly game has been developed as a case study. The game is then simulated to extract numerous role abstractions which are then mapped to real-life applications.

The organization of this paper starts with Sect. 2.2 where it highlights some of the previous works on role management. Then, the paper moves on to the findings of role management which are in the form of formal notation. The findings are discussed in Sect. 2.3 followed by Sect. 2.3.4 which covers roles' behavior in the form of rules. Finally Sect. 2.4 concludes the paper.

2.2 Related Work

In 1992, Ferraiolo et al. [5] for the first time has introduced the concept of role as a mechanism to control access to resources. Since then, his concept continues to gain popularity and branded as RBAC. His concept also has grown to be the foundation to a range of access control models. With the main intention to protect resources, RBAC structured role hierarchically as such to inherit permissions. The structure is commonly referred to as "is a" relationship [6]. Even though role was first introduced as a medium between users and their access right to resources, role eventually evolves to become agents between users and their responsibilities. The responsibilities mandate users with the right to make decision and perform collaborative tasks. The RBAC role hierarchy concept has also eased up the distribution of tasks to users where a child row can inherit responsibility from a parent row [5, 6, 8–10].

In contrast, the concept of role hierarchy has a different meaning in the context of virtual organization. It is not meant for heritance but for the purpose to structure the flow of communication and command [7]. Roles are structured as such roles at the higher level hold higher authority as compared to role at lower level. The flow of command is from top to bottom where higher roles have more right over lower role. However, flow of communication takes place in two ways which are bottom up and top down.

Another entity in the role structure is the user who is to play the roles. For productivity purposes, the area of management consistently strive to ensure that the right users is assigned to play the right role and at the right time [11, 12]. Thus, various measures have been studied to reach the best approach. In addition, the research mostly focuses on optimization specifically on human resources structure [13]. However, the structure is designed for homogeneous setting where users' skill is similar. In heterogeneous environment where users' skill varies, optimization is not as important as searching for users with suitable qualification [10]. In addition, research has also been conducted to optimize number of users per role in order to achieve balance distribution of workload [14, 15].

Relationship among roles is vital in social networking. The roles are closely interconnected with each other where any changes will affect their relationship. Consistently, role graph model are used as a medium to manage the

relationship [16, 17]. The main purpose of the model is to minimize the effect of the changes such as conflict relation, promotion, and inheritance.

The concept of role has been contributed in various research areas. In most cases, role is the medium for assigning property to users. In such cases, the true identity of users and even the users themselves are hidden. This is important in the event of information transferring for security purposes.

Role has also been employed as medium to represent users [15] where permissions and responsibilities are assigned to role prior to users. Thus, personal issue which can be an obstacle to equally distribute workforce among users can be avoided. The concept of role management is summarized in Fig. 2.1. In short, the concept of role management classifies roles into a few subgroup of:

- Manager—manages the flow of authorization and communication.
- Optimizer—manages human resources and their relationship.
- Protector—protects users' identities during information transfer.
- Task Allocator—manages workflow of tasks.
- Resource Allocator—manages access right to resources.

Most of the managements are performed by external entity such as administrator. The managements are static whose internal entities find it difficult to cope [17]. Thus, system malfunctions are not easily managed. However, the study on internal



Fig. 2.1 Role management

controlling is lacking attention. Thus, this paper intends to discover the dynamic behaviors of roles which can be utilized as internal as well as external controller. The finding is important in dynamic environment which requires flexible controlling.

2.3 Monopoly Game

The monopoly game was first created by Elizabeth Magie in 1903 who is from America. The game was called *The Landlord's Game* since it involves selling and buying properties. The main properties in the game are hotel, house, and land. By the year 1934, after releasing a few versions, a version similar to the version introduced by Parker Brothers was released. The version gains its popularity in twentieth and twenty-first centuries [18, 19]. Besides game, monopoly has also been utilized in many areas of researches such as strategic planning, economics, financing, mathematics, group behaviour, virtual community, and communication [20, 21].

2.3.1 Game Rules

In collaborative monopoly game, there are ten roles which are tourist, visitor, citizen, businessman, landlord, millionaire, tenant, prisoner, observer, and banker. The screenshot of the game is shown in Fig. 2.2.

The game is separated into two stages which are visiting and monopolizing stages

Visiting stage

All players start the game by playing the role of tourist in this visiting stage. They are authorized with basic rights which are throwing dices prior to making a move. No other authorizations are given.

The monopolizing stage

Once players have completed the visiting stage, they are moved to monopolizing stage. They are transited to citizen role and authorized to earn salary. They are also authorized to buy properties. Thus, to monopolize the game, they will strive to own as many properties as possible.

This is the stage where users consistently change their roles. For example, citizen is transmitted to landlord immediately after they buy a property. However, users have to leave the game when they are short of cash and incapable of paying other expenses.



Fig. 2.2 Monopoly collaborative game

2.3.2 Monopoly and the Analysis

R denotes the set of roles in the game where

$$r \in R = \{\text{citizen, visitor, tourist, landlord, businessman,} \\ \text{banker, millionaire, prisoner, tenant and observer}\} \quad (2.1)$$

R can be in either static or dynamic state. Let S be the set of two states which

$$s \in S = \{\text{static, dynamic}\} \quad (2.2)$$

When a role is in its static states, it blocks any current holder from releasing the role and blocks any outsider from entering the role. On the other hand, dynamic states allowed the role to freely accept or release players.

Time frames have been enforced to the state to control the role activities in that state. There are three time frames which are whole session, duration, and condition. Let TF represent the set of time frame, then

$$tf \in TF = \{\text{duration, whole session, condition}\} \quad (2.3)$$

With the time frames and states, there exist six possible combinations (static, whole session), (static, duration), (static, condition), (dynamic, whole session),

(dynamic, duration), and (dynamic, condition). Therefore, the collaborative monopoly game, M is essentially a function which assigns R to their state and time frame which can be denoted as

$$S \times \text{TR} \quad \text{where } M : R \rightarrow S \times \text{TF} \quad (2.4)$$

The function, M , is said to *freeze* all users to their role if

$$\forall r \in R, S \times \text{TF} = \{(\text{static}, \text{duration}), (\text{static}, \text{whole session}), (\text{static}, \text{condition})\} \quad (2.5)$$

Otherwise, if one or more roles are assigned to dynamic, the role is free to change its state (dynamic, static) if

$$\begin{aligned} \exists r \in R \text{ such that } S \times \text{TF} \\ = \{(\text{dynamic}, \text{duration}), (\text{dynamic}, \text{whole session}), (\text{dynamic}, \text{condition})\} \end{aligned} \quad (2.6)$$

Since this research is interested in the changes of the roles' state over time, a parameter t is included into the function which extend a semi-bounded domain

$T = [t_{\text{start}}, \infty)$, where t_{start} denotes the time at the beginning of the game. Hence, $M(t)$ is used to set the roles' state at time t and M having domain $T \times R$.

During dynamic state and at any time of the game, a controller which can be a human or an automation machine can assign new players to the roles. Thus, the controller is a set of $L = \{\text{external}, \text{internal}\}$

Since there are only two types of actions that can be performed on role which are assigning state (static, dynamic) within time frame, the action are supported by the function change where

$$\text{change} : T \times R \rightarrow S \times \text{TF} \times L \quad (2.7)$$

Let the graph of change be denoted by $C(t_a, t_b)$ and time t is bounded by $[t_a, t_b)$ where

$$C(t_a, t_b) = \{\langle t, r, l, \text{change}(t, r, l) \rangle \mid t_a \leq t < t_b, r \in R, l \in L\} \quad (2.8)$$

The function manages all the changes on roles' state throughout the time interval $[t_a, t_b)$. The changes directly affect players changing role. Therefore, a role *behavior management*, is actually a temporal function, ψ , which manages players changing roles that varies from time to time and it is defined as

$$M(t) = \psi(t, C(t_{\text{start}}, t), \text{assign}(t, r, l)), \quad (2.9)$$

where function $\text{assign}(t, r, l)$, make decision either to accept or reject any role-user assignment. However, the decisions made are based on $C(t_{\text{start}}, t)$ outcome.

Table 2.1 Roles' static *behaviors* and applications

Roles' behaviors identified from monopoly	Type of behavior	Time frame
<i>Banker</i> cannot change player throughout the game	Static-sustainable	Whole session
There will only be one <i>banker</i> at all the time	Static-sustainable	Whole session
<i>Visitor</i> and <i>tourist</i> are <i>static-interval</i> , they are active only during the first phase	Static-interval	Duration
During first phase, <i>visitor</i> , <i>tourist</i> , <i>citizen</i> , <i>landlord</i> , <i>businessman</i> , <i>millionaire</i> , <i>tenant</i> and <i>prisoner</i> are static. No users are allowed to be signed into the roles for the duration of first phase	Static-interval	Duration
<i>Banker</i> is <i>static-sustainable</i> , but manager can force new user into the role	Static-conditional	Condition
<i>Prisoners</i> are static during phase L as long as no one get double dice three time consecutively	Static-conditional	Condition

2.3.3 Monopoly and Role Behaviors

Monopoly game abstractly captures various role behaviors that are common in collaborative applications. Tables 2.1 and 2.2 list the six possible behaviors of roles. *Role behavior* is a mechanism to be used in controlling users playing roles bounded by the time frame.

2.3.4 Role Behavior and Its Model

This section discusses each of the six *role behavior*. Table 2.3 depicts relationship between *behaviors* and their rules.

Roles with dynamic-interval, dynamic-sustainable, and dynamic-conditional are dynamic, however, their timeframe are different. Similarly, dynamic-conditional is also dynamic but based on a certain condition. In contrast, static-interval, static-sustainable, and static-conditional set role on static state based on timeframe while static-conditional is based on condition.

Next the behaviors will be described in further details.

(i) dynamic-sustainable role is set by $\exists r \in R, M(t_i)(r)$ such that

$$S \times \text{TF} = \{(\text{dynamic}, \text{whole session})\} \quad \text{where } t_i \in T \quad (2.10)$$

Table 2.2 Roles' dynamic *behavior* and applications

Roles' behaviors identified from monopoly	Type of behavior	Time frame
<i>Observers</i> enter or leave the game unlimitedly	Dynamic-sustainable	Whole session
Players play <i>visitor</i> and <i>tourist</i> one time only	dynamic-interval	Duration
A player is substituted by his friend	Dynamic-interval	Duration
Roles are organized into hierarchy thus players are allowed to move up and down the rank	Dynamic-interval	Duration
Roles are distributed into phases and their activation varies with time	Dynamic-interval	Duration
Moving to phase 2. phase I's roles are set to inactive	Dynamic-interval	Duration
All roles except <i>banker</i> , <i>visitor</i> and <i>tourist</i> can be played unlimitedly	Dynamic-interval	Duration
Taking a role <i>prisoner</i> , a player will automatically drop temporarily all of his current roles	Dynamic-conditional	Condition
<i>Prisoner</i> cannot be played for more than three rounds consecutively	Dynamic-conditional	Condition

Table 2.3 Behavior rules

Behavior	Dynamic	Static	Whole collaboration	Duration	Cond
Dynamic-sustainable	√		√		
Dynamic-interval	√			√	
Dynamic-conditional	√				√
Static-sustainable		√	√		
Static-interval				√	
Static-conditional		√			√

(ii) function assign (t_i, r) will then be activated which allows, users to hold and release the role r during the whole session, t_j , where $t_i < t_j < \infty$ and $t_j \in T$.

Dynamic-interval allows users to enter and exit the role during the time frame.

(i) dynamic-interval role is set by $\exists r \in R, M(t_i)(r)$ such that

$$S \times \text{TF} = \{(\text{dynamic}, \text{duration})\} \quad \text{where } t_i \in T \quad (2.11)$$

(ii) function assign (t_i, r) will then be set to active which will accept hold and release of role throughout the specified duration. Hence, the duration is denoted by t_j where

$$t_j = [t_a, t_b], t_a \leq t_b \quad \text{and} \quad t_j, t_a, t_b \in T$$

A dynamic-conditional role will accept users only when the conditions are met.

(i) dynamic-conditional role is set by $\exists r \in R, M(t_i)(r)$ such that

$$S \times TF = \{(\text{dynamic}, \text{condition})\} \quad \text{where } t_i \in T \quad (2.12)$$

(ii) the condition will then activate function $\text{assign}(t_i, r)$ which will hold and release the role as long as the conditions are met. Let $C = \{c_1, c_2, \dots, c_k\}$ be a set of conditions. Therefore, $\text{assign}(t, r)$ is active as long as c is TRUE where $c \in C$

Static-sustainable prevents users from entering and leaving the role.

(i) static-sustainable role is set by $\exists r \in R, M(t_i)(r)$ such that

$$S \times TF = \{(\text{static}, \text{whole session})\} \quad \text{where } t_i \in T \quad (2.13)$$

(ii) $\text{assign}(t_i, r)$ will then be set to inactive which will block any hold and release of role throughout the whole session, t_j where $t_i \leq t_j < \infty$ and $t_j \in T$.

Static-interval is frequently used to stop users from entering the roles.

(i) static-interval role is set by $\exists r \in R, M(t_i)(r)$ such that

$$S \times TF = \{(\text{static}, \text{duration})\} \quad \text{where } t_i \in T \quad (2.14)$$

(ii) operation $\text{assign}(t_i, r)$ will then be set to inactive which will block any hold and release of role for a time duration. Hence, the duration is denoted by t_j , where

$$t_j = [t_a, t_b], t_a \leq t_b \quad \text{and} \quad t_j, t_a, t_b \in T.$$

Finally, static-conditional permit users to change role only by authorized personal.

(i) static-conditional role is set by $\exists r \in R, M(t_i)(r)$ such that

$$S \times TF = \{(\text{static}, \text{condition})\} \quad \text{where } t_i \in T \quad (2.15)$$

(ii) function $\text{assign}(t, r)$ will then be set to inactive and only be active if condition is set to true. Let $C = \{c_1, c_2, c_3, \dots, c_k\}$ be a set of conditions. Therefore assign (t_i, r) is active as long as c is TRUE where $c \in C$.

In short, in temporal function ψ , there exists a method $\text{assign}(t, r)$ which is authorized to monitor users taking new roles and the function is managed by

$$C(t_{\text{start}}, t)$$

where $T = [t_{\text{start}}, \infty)$, and t_{start} is the starting of the game.

2.4 Conclusion

This paper has studied role management specifically in collaborative environment. Then six role *behaviors have been identified* from a collaborative monopoly game. The behaviors signify role's states which are *static* and *dynamic* and also the role's time frames. A clear *behavior will be* used to manage users through internal and external controller. This controlling entity also enforces flexibility in managing users.

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