2018 42nd IEEE International Conference on Computer Software & Applications

Utilising Abstration Techniques and Gaming Theory for Developing Intangible Cultural Heritage

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***Abstract*— Raising the level of abstraction is to improve the ability to understand the world and then to help with computing. This paper proposes the new value of intangible cultural heritage to compute game rate on abstraction level and to instantiate and infer the other values with the same concrete information and game rate. The proposed approach is to formulate element and standard, enabling system automation to integrate and verify the flow of abstraction level. Furthermore, on the abstraction level, the game theory computes the game rate. Finally, based on instantiation rules, the abstract conception and game rate can be7 into other values in the intangible cultural heritage area. Depending on abstraction techniques, it will present the feasibility and effectiveness of this approach.**

Keywords—abstraction; abstraction levels; meta-gaming; Nash Equilibrium; model; Intangible Cultural Heritage;

I. INTRODUCTION

Many efforts have been made to increase the level of abstraction in the design procedure. Depending on the higher level of abstraction, the amount of objects in the design declines dramatically. Based on this situation, a huge number of unnecessary details has been overwhelmed. The kernel of any design flow is to formulate a kind of well-defined abstraction levels. In order to optimise choices and move among abstraction levels efficiently, the amount of levels and the attributes of each level need to be defined. The higher abstraction levels can reduce the number of objects that need to be managed. Furthermore, it can present enough information to guide search on each step, searching accuracy and efficiency. Moreover, in order to make system more synthesised and verified**,** the developer needs to define the abstraction levels clearly and unambiguously.

The main characteristic of the intangible cultural heritage is derived from lifestyle of particular ethnic nation. It presents value of the "living" of national personality and national aesthetic. The intangible cultural heritage is based on human beings. Furthermore, sound, visualisation and skills are regarded as the main expression methods. Regarding words and deeds as their cultural chain to be continued is the most vulnerable part of the intangible cultural heritage. Therefore, in the process of inheritance of intangible, the inheritor becomes even more important. The protection and development of the intangible cultural heritage need great efforts to be made in various areas. Particularly, the inheritors perform the skills. However, due to restrictions of different kinds of conditions, the inheritors are hard to survive based on this skill, leading to reducing the number of inheritors and dying out gradually. Depending on experts, government, enterprise and customers, the inheritors can use their skills to gain the profit. However, how to distribute their interests reasonably is the main problem to develop and protect intangible cultural heritage.

The aim of this research is to propose a value refinement framework to compute game rate on abstraction level and to instantiate and infer the other values with the similar concrete information and game rate. The paper is organised as follows: Section II presents related work of abstraction, abstract data type and intangible cultural heritage. Section III presents the modelling of gaming strategy. Section IV describes the approach of raising abstraction level method with explanations of different phases. Section V introduces the generation system of the new value of intangible cultural heritage as a case study, which describes how the system uses abstraction techniques to generate a plan about intangible cultural heritage area. Section VI concludes this paper.

II. RELATED WORK

This section studies the current research related to Abstraction, Abstract Data Type, Game Theory and Intanible Cultural Heritage, concluding the challenging issues of this paper described in the next part paper.

A. Abstraction

Abstraction as a conceptual procedure derives from the usage and classification of specific information, literal details, first principles and other methods based on the general rules and conditions [1, 2]. A specific concept, a strict condition, or an observable phenomenon can be regarded as conceptual abstraction to filter the information which are irrelevant to a specific subjective purpose [3]. For instance, abstracting a phone from Samsung to the more general ideas of a phone only chooses the information on general phones attributes and instruction, excluding, the other condition and cognitive characteristics of that specific phone**.**

An abstraction can be regarded as an induction procedure, mapping different kinds of generalised data to a single type of abstract data on the basis of similar characteristic [4]. For instance, many different kinds of physical apples can be

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0730-3157/18/$31.00 ©2018 IEEE
DOI 10.1109/COMPSAC.2018.10331

abstracted to the abstract conception of "APPLE". This theoretical structure focuses on the internal connection between generalised data and abstract data [5]. The aim is to distinguish the conceptual "abstract" and "generalised". The procedure of abstraction is to identify the similar characteristics among objects and to induct these objects with an abstraction [6, 7].

For instance, it presents the generalised conception "An apple is on the table". The chains of abstraction can be established, deriving from observation to basic abstraction such as shape or colour, from experientialism to basic abstraction such as a particular apple, from semantics to basic abstraction such as the "conception" of an apple, from classification to objects such as "fruits" [17]. In the main sense, the whole sentence can be abstracted as "item is in the location". This theoretical structure does not need particular hierarchical taxonomy [18].

It is easy to be accepted that non-existent things in any special place and time are considered to be abstract. On the other side, for example, such an abstract thing possibly exists in many kinds of places and times. These kinds of abstract things are regarded as various instantiation, like the example "an apple is on the table". However, it is not enough to define the abstract ideas based on instantiation and to define the abstraction as the opposite direction to instantiation [19]. "Apple" can be regarded as an abstract conception because of its multiple appearances. A specific apple is an instance of the concept "apple". Although "apple" is an abstract conception, it is not abstract in the sense of the objects. In the process from apple to fruit to botany, the botany is more abstract than fruit, however, the concept of fruit is much harder to be expressed. By contrast, the boundary between generalisation and abstraction is very ambiguous. For example, the "apple" is the generalisation concept in last example. However, with a progression from abstraction to generalisation, the concept "apple" can be instantiated in three levels.

(1) An apple

(2) A Gala

(3) A Gala I bought on 9th March

The physical objects differ from the abstract conception [8]. This kind of difference accounts for the conception of "abstract". It is used to mark the properties and relations. However, they do not exist in space or time. Furthermore, instantiation of them can exist in various places and times potentially. Abstract characteristics are considered non-existent in the places and times. However, it is hard to decide which is real. It is difficult to accept whether the conception of God is real, abstract or both.

B. Abstract Data Type

In computer science, an abstract data type (ADT) is a mathematical model for data types whose behaviour (semantics) is defined by a set of possible data values and a set of possible operations in the data users' perspective [14]. Compared with an abstract data type, data structures are in the implementers' perspective rather than data users' perspective, representing concrete data [15].

Making the state of a computation be shown as a graph is the basic idea of graph transformations which can be used as a computation abstraction. On this graph, further steps in this computation can be shown as transformation rules that are made up of an original graph. The original graph will match with the subgraph in the complete state, and a substitutive graph will replace the matched subgraph [16].

C. Intangible Cultural Heritage

The greatest characteristic of intangible cultural heritage is the special ways of life and production which are not separate from the nation. It is the actual expression of national character and national aesthetic habit. It exists dependence on human beings themselves, and is represented by sound, visualisation and skills. Also, it is continued by ways of words and deeds as a cultural chain， and it is the most vulnerable part in actual culture and tradition.

In regard to intangible cultural heritage, it usually focuses on the rescue of particular national minority culture, especially on those of small population based on the verge of disappearance. This is absolutely a very important aspect on the protection of intangible cultural heritage. Meanwhile, one question is raised "can intangible cultural heritage be widely covered by most area of the country, rather than be restricted in the difference of gender, wealth, trades as well as faith. " In the Chinese nations, we need to explore the influence of 56 nationalities family members, and also explore if we can break through intangible cultural heritage of particular nations, local area, special time and some trade.

Intangible cultural heritage is the expression way of traditional culture, which exists based on various unphysical forms and is close to people's life. The intangible cultural heritage is people oriented cultural heritage. It emphasises to take humans as the core skills, experience and spirit. Its characteristics are the living state rheology. It presents unphysical attributes and more emphasis on character that does not depend on physical form. However, in today's society, intangible cultural heritage is also inevitably materialised in different degrees during the declaration process. How to avoid excessive materialised packaging situation of intangible cultural heritage, break through limitation of physical form as well as keep the nonphysical characteristics of intangible cultural heritage is the necessary attitude to respect the heritage left by our ancestors.

D. Game Theory

Meta-gaming is any tactics, action or skill which are used in a game. It has an effect on the game with the use of external factor， goes beyond the specified ruleset or exceeds the restrictions or environment set by the game. Meta-gaming, on the other side, is defined as the game world outside of the game itself [20]. For instance, another player who actually should not know the current player's information is told current player's information or something they are doing by someone in role play situation. In brief, affect one's determinations in the game by using information or resource out of the game.

The term meta-game is a mathematic descriptor for set interaction governing subset interaction. The term meta-game made a transition from military use to political wording [21]. It states events outside of traditional limitation, which actually has important effects on the outcome of the game. For instance,

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Military action might be a game, but its political embranchment would be the meta-game. In a similar way, the passage of a law might be a game, however, the political environment suitable for the law would be the meta-game.

E. Summary

It is well accepted that general distribution cannot completely meet players' requirements. Therefore, it is proposed that abstraction is used to formulate different input methods from different players, while abstract data types are used to calculate maximisation profit by reusing information. Furthermore, abstract data types are used to bridge the connection between the relational databases and previous databases, ensuring the new value of intangible cultural heritage. In the next section, a new system process comprising abstraction rule is proposed first and then how to apply these two technologies to the new value of intangible cultural heritage is suggested.

III. Design Raising abstraction level System

The challenge is not to reinvent new analysis methods which aims to profit distribution, but to connect the gap between profit distribution on intangible cultural heritage and existing abstraction techniques. In this presented approach, raising abstraction levels formulates kinds of effort methods, which reduces the semantic gap. The well-defined abstraction levels map the source models and target models. Furthermore, it is necessary to aggregate the number of relational source model factors based on certain abstract algorithms, and to map the entire aggregation to a particular target element. The grouping algorithms map to the raising of abstraction level for connecting the semantic gap between the relational information and the objective model. Therefore, the algorithms are based on the semantic differences between the information and objective model, and are not on behalf of the source meta-model.

The concrete concept has different kinds of meanings. Based on the meaningful concept, inferred process of the game is objective and rigorous. However, the objective and rigorous results are hard to satisfy the subjective requirements. According to the subjective definition, abstracting the character from the concrete concept raises the level from generalisation to abstraction. On this level, the inferred process of the game is subjective and purposeful. The subjective requirements are easy to be achieved based on this set of inference.

Abstraction data is a set that contain thousands of data. The data in this set is the same class. On abstraction level, the rules mapping two different abstraction data are similar to mapping two set with thousands of data. The design uses a large amount of related data to refer and game subjectively. It cannot be achieved on generalisation level.

This paper proposes a raising abstraction level system (RALS) as can be seen in Figure 1. There are three kernel phases to generate the related intangible cultural heritage with similar conditions, including "Raising to Abstract Level" "Gaming at Abstract Level" and "Generalising to Results". This paper focuses on the first phase and the second phase, as its main function is to formulate the standard based on different type value form from players, to abstract the formulation data and to game the metadata on abstract level. More information is illustrated on these three phases in the following sections.

The design system defines the generalisation level, terminal, abstraction rules and abstraction level. In this design, the generalisation level is defined by the type of value. The abstraction level is hierarchically composed out of generalisation level ones. In the generalisation levels, the design can be depicted in the form of the fundamental and instantial models. A fundamental model depicts the list of physical components and their standards, and its aim is to formulate the components and to process the data to a higher level. An instantial model depicts the physical components that are refined from metadata on abstraction level. The instantial model aims to represent different kinds of components according to one single metadata. On abstraction level, the design can be depicted in the form of a manipulative model. The manipulative model depicts the desired functionality as a composition of mapping functional entities. The aim of manipulative model is to activate the mapping algorithms, process input metadata, produce output metadata, and terminate.

A. Raising to Abstract Level

Phase 1: Raising to Abstract Level. This phase is to gather and abstract data by abstraction techniques, designed abstraction rules and algorithms. At the beginning stage of the system, it will receive various sets of concrete data from one concertation concept. The system will abstract these concrete data. Furthermore, this abstract information illustrates an abstract conception after abstracting. Meanwhile, these sets of concrete data are abstracted to generalization level depending on the request of the system. The design depicts the desired abstraction of implementation details. The aims on the generalisation level is to abstract entities that perform computation on data. On the generalisation level, a design consists of computation and abstraction. The computation is to analyse and reuse different sets of components and to formulate different sets of conditions.

In the intangible cultural heritage model, there are two levels. The first level contains concrete value data. Each value has their own style of working and specific characteristics of working. The object of first level is to gather these kinds of data and formulate these kinds of data according to abstraction rules. The abstraction level contains abstraction of value data. The aim is to gain data from lower level and to process formulaic abstraction data in meta level.

The algorithm is to abstract the sets of generalisation concept "value" into abstract conception "value". In the abstraction process, it is a triple

$$(TP\ AR\ AP)$$

consisting of a type of value TP, a set of abstraction rule AR, a set of abstraction of value AP that defines the rules to abstract characteristic from fundamental data and transfer to metadata. $AP \subseteq TP * AR$

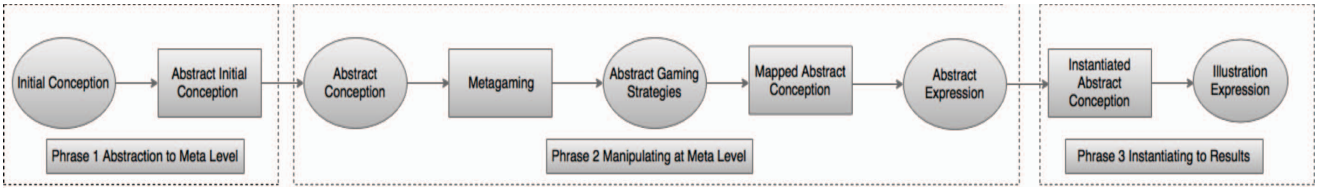

Fig. 1 The Process of New Value Form of Intangible Cultural Heritage

A factor $e \in E$ is defined as a triple (TP_e, AR_e, AP_e) that operates the type of value TP_e abstracted onto it. Type of value inside factors is connected by a set of abstraction rules AR_e as defined by $AP_e \subseteq TP_e * AR_e$. As the inherently consecutive attribute of factors, the factors from the type of value have to be serialised. The tasks consist of type of value. The abstraction rules in the design dispatch the tasks. After that, mappings from metadata to relational metadata resources are straightforward on abstraction level. It can be described as one-to-one relations between abstraction factors of the two metadata models. For example, each character is mapped to a relational model, each provided interface of a character is mapped to a service suggested by the model call and so on. However, a number of cases that aggregate all of characters entirely in the metadata model are mapped to a single relational model character. The meta level is a triple

$$(AE, MR, RAM)$$

Consisting of a set of abstraction element *AE,* a set of mapping rule *MR*, a set of relation abstraction model *RAM*. *AEs* are abstraction objects, representing abstraction characteristics. In general, the set of *AEs* in the design, $AE = O \cup IP \cup R$, consists of a set of general object processors, asset of IPs, and a set of records.

An $ip \in IP$ is defined as a pair (TP_{ip}, AP_{ip}) The abstraction of value abstracts the internal connection and supplies a set of abstraction rules interfaces for connecting with the *IP* at the meta level. At the meta level, abstraction element can be bridged directly with those relation abstraction model. The system relation abstraction model $RAM \subseteq TP * (MR \cup AP)$ maps to Abstraction element $AE = U_{ip \in IP} AP_{ip}$. The meta level manipulates abstraction data by aggregating abstraction factors and mapping them to relation abstraction models

The aim is to increase the dimensionality from physical components to abstraction data, focusing on specific characteristic and leaving the irrelevant and useless details in the basic hierarchy. It also transfers data into one single formulation. It is easy to compute and manipulate the data. The parallelism between the individual value is explicit by their concurrent conditions. Computation and abstraction are separated into management and abstraction respectively, assisting a separate implementation of both concepts.

B. Gaming at Meta Level

Phase 2: Gaming at Meta Level. It is to map the metadata on abstraction level. From the abstraction level perspective, the manipulating metadata can be described as follows. The characters and factors of metadata are mapped onto relational resources. Based on provided and required interfaces, each character needs to face the correspondingly offered and required services. The reasonable metadata activity leads to the behaviour of each offered service. According to the abstraction "value", the design acquires a type of "value". In this class, there are many different types of "value". It enlightens and evolves the current strategic trends. In this stage, the main point of the game is how to make players gain more profits. For this purpose, adding some extra data, such as more diversified value form promotes the public acceptance on the culture and history of intangible cultural heritage. Intangible cultural heritage provides creative thinking for other projects, makes more profits for the value and also increases each players' profits. However, game with adding abstract conception aims to making products gain more extra profits and making each participant gain more profits. It is hard to compute two conceptions in different dimensionality, if the system computes the abstract conception on generalisation level. Depending on this abstract data, game theory modifies the type of gaming, letting the products gain more profit.

The information from modelling, the unit cost of developed product is C_i, the price of intangible cultural heritage product is $B_i \in$, and the travel value of intangible cultural is $V_i \in$, the abstract data from first step, which is product-value $P \in (0\text{-}1)$, self-value $S_e \in (0\text{-}1)$ and social-value $S_o \in (0\text{-}1)$. Three parameters affect the abstraction value, which are government parameter, enterprise parameter and inheritor parameter. Government parameter (X_g) affects the social value, enterprise parameter (X_e) affects the product-value, and inheritor parameter (X_i) affects the self-value. The sum of these three parameter is 1. Based on previous studies, the system defines that the enterprise parameter X_e is 25%, the inheritor parameter X_i is 35% and the government parameter X_g is 40%. The algorithm of the game rate is design below:

$$Game\ rate = (X_e * P + X_i * S_e + X_g * S_o) * 100\%$$

The aim of this step is to manipulate the metadata based on rules of gaming. There are three levels of rank in this design. If the results are below 40%, it means this set of value is with bad profits. If the results are from 40% to 60%, it means this type of value is with normal profits. If the results are over 60%, it means this type of value is with good profits. Finally, the system instantiates the abstract conception and suggests a type of similar value of intangible cultural heritage with the similar profit.

C. Generalising to Resutls

Phase 3: Generalising to Results. It expresses concrete type of values. Abstract conception is a class concertation concept which can be expressed in different ways. In the process of instantiation, the abstract conception can provide different kinds of results according to the player's requirements. In this part, the conception of "value" will be divided into two level to be analysed from higher level to lower level, which is abstraction of value and concrete value. According to mapping rules, abstraction "value" on the abstraction level is generated. After

abstraction level, it is the instantiation part that is to instantiate resutls by designed rules, which is one of further studies.

IV. CASE STUDY

The abstraction level framework proposed in the previous section are implemented and developed, which is called the Rasising Abstraction Level System (RALS). A prototype of the RALS is presented to demonstrate and prove that the proposed process and abstract factors are feasible to generate new concrete conception based on metagaming and Nash Equilibrium, which helps to develop intangible cultural heritage.

As intangible cultural heritage project, the main customer group of Chinese folk art forms is those people who are around 40 years old. It is held once a month, and the value venue is small theater. The performer is a person who has worked on this project over five years. He just needs a table when he performs his program that is storytelling. This value can make the public learn more about ancient history events of China, make more audiences watch Chinese traditional programs as well as provide more new elements for more programs. The system will extract relevant data from these data for abstraction. The system will choose nine of data for abstraction, which are people over 40 years old, small theater, one time once a month, over five years, storytelling, a table, historical events, traditional program and new elements. According to abstraction algorithm, the previous three of specific data will be abstracted for product price. The middle three of data will be abstracted for self-value. The last three will be abstracted for social value.

The system accepts these data and constructs concrete conception "Chinese folk art forms value" with these data. The system will abstract these data to the abstract conception of intangible cultural heritage based on the characteristic of Chinese folk art forms that belongs to intangible cultural heritage after it receives these data. Thus, the abstract conception "intangible cultural heritage" consists of product value, self-value and social value.

On the abstraction level, the project with the abstract conception will obtain extra abstraction attributes by metagaming, such as how to make the value diversified and how to generate more creative value etc. The design will gain the game strategy of abstract in this process. After adding new abstraction attributes, the entities values can desire more profit, ensuring each players with a high revenue. Furthermore, based on the algorithm of game rate, the result of Chinese folk art forms is 65%.

After this, the system will express abstract conception as concreate conception. On the abstraction level, there are three abstract conceptions which are product value, self-value and social value. Product value will be expressed as facing people around the age of 40 and value venue being in the small theatre. Self-value will be expressed as traditional entertainer's value and its value form is a way of speaking. Social value will be expressed as traditional arts and historical events. All value that have theses six specific data will get 65% of the game results. In other words, intangible cultural heritage project with theses six conditions will have a better development, such as stand-up comedy, Chinese shadow puppetry and Peking opera etc. To illustrate the designed abstraction factors and corresponding algorithms, the generated information are shown in Table 1.

Table 1. concrete factors and relation intangible cultural heritage

	Chinese Folk Art Forms	**Value**	**Relation Intangible Cultural Heritage**
Victor$_1$	40-50 Years Old	Product-Value	Stand-up Comedy
Victor$_2$	Small Theatre		
Victor$_3$	Once a Month		
Victor$_4$	Over Five Years	Self-Value	Chinese Shadow Puppetry
Victor$_5$	Storytelling		
Victor$_6$	A Table		
Victor$_7$	Historical Events	Social-Value	Peking Opera
Victor$_8$	Traditional Program		
Victor$_9$	New Elements		

V. CONCLUSION

In general, it is hard to complete the system design process in a single step. The semantic gap between requirements and implementation desires to be connected. Therefore, the design needs to divide the process into multiple levels. In this paper, raising abstraction level is proposed to game among different players, which aims to protecting and developing the intangible cultural heritage. Moreover, abstract characters with corresponding algorithms are designed to game. A prototype of the rasising abstraction level system (RALS) is developed based on the proposed value eveluation, in which raising abstraction level algorithms and game theory. Related studies on abstraction levels are reviewed and metadata model is created. The metadata model is the abstraction knowledge, supporting the metadata mapping. The process of instantiation connects the potential understanding between the abstraction knowledge and fundamental knowledge. This paper illustrates the proposed methods and algorithms that can be applied in real-world scenario, assisting the abstraction and instantiation on the further possible researches in abstraction domain. To improve and promote this research, one direction of the further work is to extend the usage by raising abstraction level in pervasive domains.

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