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"Creativity Engine": A Creativity Support System for Internet Content Creation

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Abstract. With the development of artificial intelligence technology, intelligent algorithms have brought tremendous changes in transportation, finance, entertainment and other fields. This paper is based on the theory of Geneplore Model, combined with intelligent algorithms, providing a method to realize creativity support system model. The framework of the "Imagination Engine" Scenario Model is constructed through the Interpretation Structure Model (ISM), which is the CSS methodology in the field of the Internet content creation. With this methodology as the guide, using Python to develop the software that is used to deconstruct the content creation of "Office Ms. Yeah", one of the Internet's head content providers. A weighted Euclidean Distance is constructed to evaluate the simulation performance, and then verify the effectiveness of this methodology. Finally, this paper gives the conclusion, the application condition, the limitation, and the subsequent improvement ideas.

1. Introduction

Since the commercialization of the development of Internet commercialization, the content production paradigm has undergone the following changes: The digitization of traditional media production under the Internet content dividends opportunity, which digitizes existing knowledge of traditional media and then transports into the Internet. The DGC (Data-Generated Content) production paradigm under the Internet data dividends opportunity, which automatically extracts content from big-data through technologies such as data mining. The MCN (Multi-Channel Network) production paradigm under the Internet creative dividends opportunity, which produces and operates IP (Intellectual Property) by incubators of net star.

In the near future, when the creative dividend gradually disappears, the core ability to support the continuous output of high-quality content is creative productivity. Human creativity is limited, so in order to maximize creativity, we need to introduce Creativity Support System(CSS) [1]. CSS is a set of computer-based tools designed to inspire users to break through the previous thinking and creatively solve problems [2]. There are different CSS research approaches caused by scholars in different fields that mainly include the following aspects:

1) The researches focus on interpreting and understanding creativity from the approach of cognitive methods. For example, Walllas, a British psychologist, proposed four stages of creative thinking [3]; Finke, American psychologist, proposed the Geneplore model [4]; Boden, British psychologist, proposed Boden's creativity model [5];

2) The researches focus on the efficiency of knowledge discovery from the approach of database [6];

3) The researches focus on finding the optimal solution from the approach of machine learning [7];

4) The researches focus on maximizing utility from the approach of creation techniques, such as G.S.Altshuller, the Soviet scholar, proposed the TRIZ theory [8].

The research results on CSS only provide the methodological basis. In practice, it is necessary to know the concrete problems and operation modes of specific industries and to give the realization methods in specific areas (ie. special solutions). This paper takes Internet content creation as an example to study how to apply CSS methodology in this field.

The research ideas of this paper are as follows:

1) Starting from the origin of cognitive method, deriving method based on the Geneplore model [4];

2) Constructing scenario model framework of the "Creativity Engine" by Interpretative Structural Modeling (ISM), which is the CSS methodologies in the field of content creation;

3) Using the method as a guide to develop instances, reproducing content creation for the Internet top content provider "Office Ms. Yeah";

4) Building weighted Euclidean distances to evaluate simulation performance and verifying effectiveness of this methodology;

5) Finally, providing a conclusion of applicable conditions, limitations, and subsequent improvements.

2. Methodology of Creativity Support System

The methodology of this creativity support system is based on Geneplore model theory to create a LEDFIT scene model as superstructure. The essence of this methodology is to transplant the creativity model theory into the Internet content creation field, forming a locally applicable methodology based on the main theme of the scene.

2.1. Geneplore Model Theory

From the approach of cognitive methods, Finke[4] believes that creativity recognition is not a single process, but an integrated product of multiple processes, and proposes the Geneplore model, which includes the Generation of Pre-Inventive Structures, the Pre-Inventive Exploration and Interpretation, and product constraints. The Geneplore model is illustrated in Figure 1.

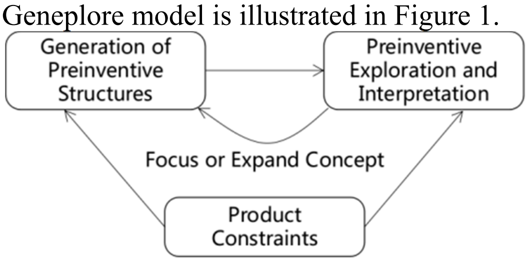

Figure 1. Geneplore Model

The Generation of Pre-Inventive Structures (GPIS) focuses on memory extraction, association, synthesis, transformation, analogy, and refinement. The Pre-Inventive Exploration and Interpretation (PIEI) module focuses on attribute discovery, conceptualization, function inference, context transfer, and hypothesis testing. The results of creative awareness can be focused or expanded based on product constraints module.

In order to innovate CSS, three main models of "Creativity Engine" are studied specifically based on the three important modules of the above theory as follows:

1) A negative feedback system is constructed by upgrading the product constraints model of Geneplore model to form the LEDFIT scene model;

2) According to the idea that hierarchical structure can effectively reduce the complexity of a system, optimizing the internal structure of the GPIS of Geneplore model, and constructing the scene pattern library and the scene layering designer;

3) In the same way, layering the PIEI modules of the Geneplore model, and constructing the scene funnel group.

2.2. LEDFIT Scene Model

To construct a negative feedback system requires the use of mathematical tools. The ISM is a structural modelling technique commonly used in system analysis. When the number of analyzed elements is numerous and the relationship is intricate, ISM can play an important role by using directed graphs, matrices, and computer technology to explain the hierarchical structure of elements qualitatively and help make rational design within the system [9].

Correlation analysis is performed on each factor, and then forms a relationship diagram which is based on the Geneplore model. In order to accurately determine the hierarchical structure of the system and the relationship between the factors and to extract the most direct and critical factors affecting the system, an expert interview is used and the results are organized and analyzed (The process is omitted). According to the relationship between the factors in the previous step, the number “0” means there is no direct effect, and the number “1” means there is a direct effect (one-way, from bottom left point to top right). In this way, we get the adjacency matrix A and the sum of matrix A and its unit matrix I of the same order which are illustrated in Figure 2.

		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
Scene Element	S1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Scene Components	S2	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Scene Template	S3	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Environment Variables	S4	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0
Time/Space & Situation FSM	S5	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Element Synthesis	S6	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Laugh Point/Value Implantation	S7	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Hotspot/Calendar FSM	S8	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
Scenario Refinement	S9	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
Logic Funnel	S10	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Business Value Funnel	S11	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Feasibility Funnel	S12	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Timing Funnel	S13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
Scene Pool	S14	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0
Scene Concept Design	S15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Scenario Development	S16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Scene Implementation	S17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Scene Operation	S18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Figure 2. Sum of Adjacency Matrix A and its unit matrix I of the same order

Continue to construct the powers of the matrix (A+I) for a positive integer n until the following constraints in equation (1) are met.

$$M = (A+I)^{(n+1)} = (A+I)^{n} \neq (A+I)^{(n-1)} \tag{1}$$

Reachability matrix M is calculated by Matlab as shown in Figure 3.

		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
Scene Element	S1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Scene Components	S2	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Scene Template	S3	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Environment Variables	S4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Time/Space & Situation FSM	S5	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Element Synthesis	S6	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Laugh Point/Value Implantation	S7	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hotspot/Calendar FSM	S8	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Scenario Refinement	S9	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Logic Funnel	S10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Business Value Funnel	S11	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Feasibility Funnel	S12	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Timing Funnel	S13	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Scene Pool	S14	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Scene Concept Design	S15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Scenario Development	S16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Scene Implementation	S17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Scene Operation	S18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Figure 3. Reachability Matrix M

Using Matlab to generate hierarchical relationships through inter-level decomposition, there are 9 layers: the first layer includes S4, the second layer includes S1-S3, the third layer includes S5-S8, the fourth layer includes S9, and the fifth layer includes S10-S14, layers 6-9 includes S15-S18. In order to form a negative feedback mechanism, a "data tracking" module is added. The result of the sorting is illustrated in Figure 4.

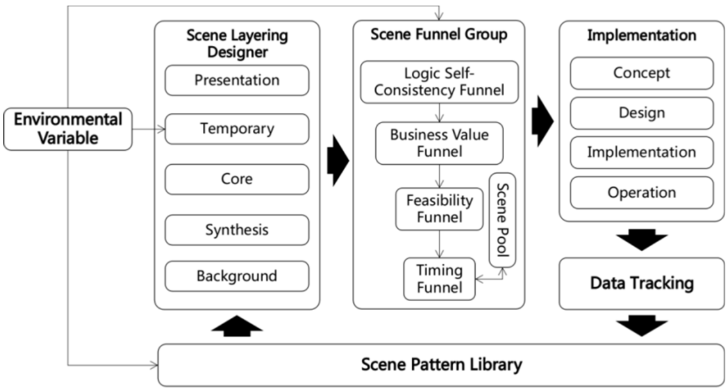

Figure 4. LEDFIT Scene Model Generated by ISM

L: The Scene Pattern Library (SPL) supplies the raw materials of the system;

E: The environment variable is the input of the system, the change of the space-time condition will affect the output of the system;

D: The Scene Layering Designer (SLD) is the creative synthesizer of the system;

F: The Scene Funnel Group (SFG) is the PIEI module of this system;

I: Scene implementation is a manual implementation;

T: Data tracking is to form a negative feedback mechanism for the system, and the next iteration is optimized by optimizing the Scene Pattern Library.

Cycle like L-E-D-F-I-T reciprocates to achieve self-renewal of the system under human control.

2.3. Scene Pattern Library

The memory extraction module of GPIS of the Genelore model is further optimized. The goal of the optimization is to increase the multiplexing rate and reduce the system complexity. Therefore, the SPL is constructed and layered as in Figure 5.

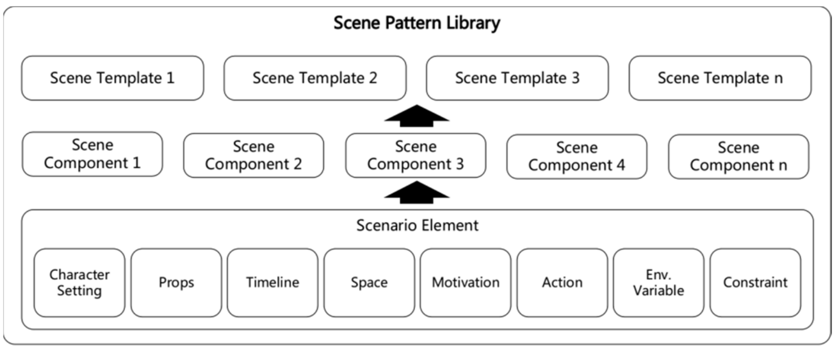

Figure 5. Scene Pattern Library

There are 3 layers in The SPL. The bottom layer is the Scene Element Layer (SEL), the middle layer is the Scene Component Layer(SCL), and the top layer is the Scene Template Layer(STL). There are 8 elements in the SEL: character settings, props, timeline, space, motivation, actions, environment variables, and constraints, which can be added or deleted according to the actual situation of the project. Taking timeline element as an example, the exhaustive elements may include (but are not limited to) time subcategories (Morning, Noon, Evening, etc.), seasonal subcategories (4 seasons in China, 3 seasons in Southeast Asia, etc.), holiday subcategories (Valentine's Day, April Fool's Day, etc.) and so on.

Each component in the SCL is an encapsulation of a typical combination of several scene elements, the purpose of which is to increase the scene hit rate. Each template in the STL is a typical combination of several scene components, the purpose of which is also to improve the scene hit rate.

2.4. Scene Layering Designer

All 5 modules of Genepolore model including the association, synthesis, transformation, analogy, and refinement of the GPIS are integrated and optimized as a layering designer that contains 5 layers illustrated in Figure 4.

The background layer contains a Finite State Machine (FSM) of time-space a situational FSM, a sensitive word masker etc., which play a role of constraint at the source to save the calculation power.

The synthesis layer contains element synthesizers, the role of which is to massively and randomly synthesize templates, components, and elements in the SPL.

The core layer contains the smiling point generator and business value implanter. The smiling point generator includes exaggeration module, homophone module, distortion module, inversion module, nested module etc.. The business value implanter includes soft advertising module, hard advertising module, and public welfare module etc..

The temporary layer contains hotspots FSM and calendar FSM, which play a role in catching up with the trend.

The presentation layer contains a scene refiner, the function of which is to process and organize raw data into Structured Scenario Description Language (SSDL) that can be understood by both machine and human.

2.5. Scene Funnel Group

Figure 6 illustrated the optimization of the PIEI module of the Geneplore model and the construction of the Scene Funnel Group.

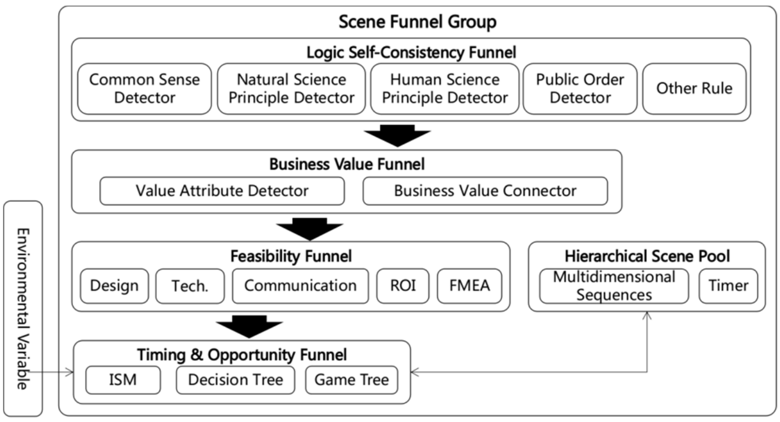

Figure 6. Scene Funnel Group

There are 4 layers in SFG from top to bottom: Logic Self-Consistency Funnel (LSCF), Business Value Funnel(BVF), Feasibility Funnel(FF), Timing and Opportunity Funnel(TOF).

The LSCF funnel includes sub-funnel like a common sense detector, a natural science principle detector, a human science principle detector, and a public order detector etc., which is used to eliminate contradictions as much as possible to achieve self-contained state and realize the “right method”.

The BVF funnel contains a business value attribute detector and a business value connector, which is used to realize business value and social value in accordance with human needs, and to achieve "with/for the right person/organization".

The FF funnel includes feasibility validation sub funnels for design, technology, communication, ROI prediction, FMEA, etc., which is used to do “the right thing”.

The TOF funnel includes the ISM model, the decision tree model, and the game tree model to do things “at the right moment” or move into a hierarchical scene pool when do not meet the current conditions. The hierarchical scene pool contains multidimensional sequences and timers to facilitate the management of the scene and automatically output the scene at the right time.

Under the combined effect of the above funnel group, the ideal situation that at the right time, with/ for the right person/organization to do the right thing with the right method can be achieved.

2.6. Structured Scene Description Language

Aiming at the characteristics and requirements of Internet content creation, a structured scene description language(SSDL) suitable for describing the creative support process based on JSON is constructed, which is characterized by self-description, simple structure, easy implementation, convenient human reading, for example:

```
{"spaceName":"Office", "room":[
 {"name":"Lobby", "light":false},
 {"name":"Bathroom", "light":true}]}
```

Using the above code as an example, the described scene element is the "office" space, in which there are two sub-spaces, one is a light-off lobby, and the other is a light-on toilet.

2.7. Summary

The above is the methodology of the construction of CSS for Internet content creation. In practice, it is also necessary to customize the project with a specific situation, especially in the early stage of the project to make adequate preparations, as illustrated in Figure 7.

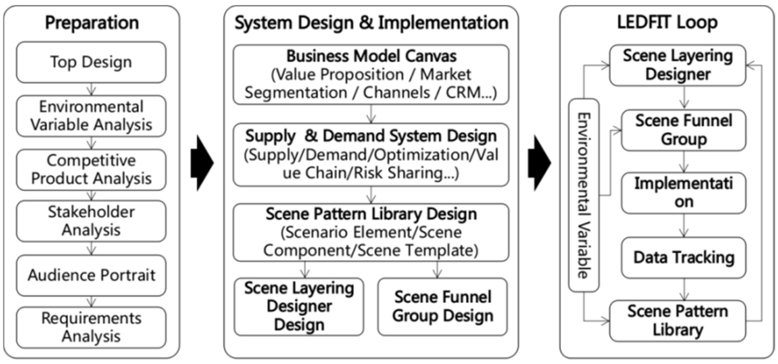

Figure 7. The framework of the CSS methodology of "Creativity Engine"

In practice, each module can be considered based on actual conditions, implemented by a machine, or temporarily implemented manually, and coded at suitable time.

3. Demo Instance

3.1. Demo Instance of "Creativity Engine"

Content creation mainly comes from experience and inspiration, while when the creativity tends to be depleted it needs to solve the problem of how to keep creative output sustainable. With Creativity Engine as the guide, using Python to develop the software that is used to deconstruct the content creation of "Office Ms. Yeah", a typical example of creative cooking video producer[10], then verify the validity of the methodology by comparing the training set and the verification set.

3.2. Configuration of Scene Pattern Library

The training set is based on the episodes 1 to 10, the concept of this show, the office product catalogue of Deli® [11], the appliances catalogue of ZOL®[12], and the foodstuff catalog of Xiachufang App®[13] to configure the SPL.

The props library covers 14 sub-libraries such as propOfficeSupplies and propTableware, and has a total of 721 items which has tagged and managed according to physical and chemical characteristics such as flammability, conductivity, and water solubility; The timeline library covers 7 sub-libraries such as timelineSeason and timelineHotspot, and has a total of 118 items; The space library covers 4 sub-libraries such as spaceOffice, spacePeripherals, and has a total of 39 items; The character setting library covers 3 sub-libraries such as characterColleagues and characterPartners, and has a total of 32 items; The action library covers 3 sub-libraries such as actionDiet and actionOutside, and has a total of 156 items; The environment variable library covers 7 sub-libraries such as envvarWorkStates and envvarEmergencies, and has a total of 236 items; There is no motivation library in the case of a simple relationship between the characters.

By aggregating typical tags into SCL such as "Sunny & Roof & Magnifier & Grill", "Foodstuff & Makeup & Tricky to Colleagues" in total of 166 Components and combining several typical scene components into scene templates, such as "Office Tricky Series", "Business Trips Series", and "Celebrity Interview Series", finally has 12 templates in STL.

3.3. Configuration of Scene Layering Designer

The bottom layer is the background layer, which contains several Moore FSM and Mealy FSM. The Moore FSM includes space FSM, timeline FSM etc., and the Mealy FSM includes situation FSM, sensitive word mask FSM etc.. Taking the space FSM as an example, the design mainly considers the influence of four space state transitions on other scene elements, which is illustrated in Figure 8.

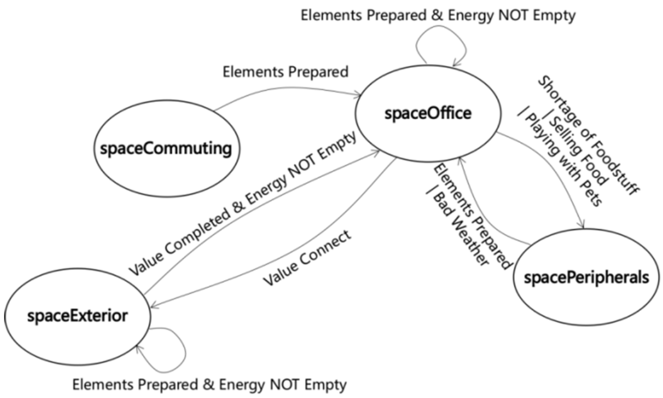

Figure 8. Space FSM of Office Ms. Yeah

The initial space state can be any place, but the main space occurs in the office (spaceOffice) or in the location of value connection (spaceExterior). The role of commuting space (spaceCommuting) is to prepare elements for scene descriptions. The role of the surrounding space (spacePeripherals) is mainly to prepare elements or release excess energy, including but not limited to selling food and playing with pets.

Above the background layer, the synthesis layer contains the element synthesizer, that uses the *random.seed()* function, a pseudo-random way to synthesis a large number of templates, components, and elements in SPL. The advantage of pseudo-randomness is that it can be reproduced the simulation results by inputting the same seed. The core layer is equipped with a business value implanter to perform brand matching on the items in the show. The temporary layer is configured with a hotspot FSM, of which the type is Mealy-type FSM, referring to the relationship between state transition and input. The presentation layer is equipped with a scene refiner, to process and organize into SSDL and output to the log file.

3.4. Configuration of Scene Funnel Group

The simulation times of this demo instance are under 1 million times, so there is no configuration of Scene Funnel Group, using pre-processing scripts to implement as instead.

4. Validation verification

4.1. Classification and Definition of Scene Attribute

Scene Attributes include genre features, cooking features, environmental features, and creative features in a total of 4 categories and 8 items. In the following sections, weighted Euclidean distance is used to measure performance. The weight ratio is set by public awareness. The detailed definition is shown in Table 1.

Table 1. Classification and Definition of Scene Attribute

Class	Attribute	Weight	Definition
Genre Features	C1 Genre	0.20	Office Tricky, Field Survival Series, etc.
Cooking Features	C2 Cooking Style	0.10	Cuisine, Category
	C3 Kitchenware Combination	0.10	Non-traditional Kitchenware and their Combination
	C4 Foodstuff Combination	0.05	Foodstuffs and their Combination
Environmental Features	C5 Time	0.05	The Time Series of Scenes
	C6 Space	0.10	The Space Transformation of Scenes
	C7 Other Conditions	0.20	Props, Constraints, etc.
Creative Features	C8 Laugh Points	0.20	Misinterpretation, Exaggeration, Homophony, Reversal, etc., and their Combinations

4.2. Performance Metrics

The verification set is calculated in 11 to 62, a total of 52 records. It disassembles the scene of the verification set according to the scene attributes. A verification scene is recorded as x_{ik}, i represents the number of episode, and **i**$\in$[11,62], k refers to the scene attribute, and **k**$\in$[1,8].

The simulation scene is recorded as x_{jk}, **j** is the number of the simulation scene, and **j**$\in$[1, simulation times]; **k** is the scene attribute, and **k**$\in$[1,8].

The weight of scene attribute is recorded as α_k, **k**$\in$[1,8], and the sum of all weights is calculated as in equation (2)(3).

$$\sum_{k=1}^{8}\alpha_k=1 \tag{2}$$

$$\alpha1:\alpha2:\alpha3:\alpha4:\alpha5:\alpha6:\alpha7:\alpha8 = 4:2:2:1:1:2:4:4 \tag{3}$$

Weighted Euclidean distance (W.E.D.) is calculated as in equation (4).

$$d_{ij}=(\sum_{k=1}^{8}\alpha_k(x_{ik}-x_{jk})^2)^{1/2} \tag{4}$$

Definition 1. Attribute Distance

For a specific scene feature k, if the verification set x_{ik} is consistent with the training set (simulation set) x_{jk}, then the Attribute distance is defined as 0 in equation (5).

$$x_{ik}-x_{jk}=0 \tag{5}$$

If the verification set x_{ik} does not consistent with any training set x_{jk}, then the attribute distance is defined as 1 in equation (6).

$$\left|x_{ik}-x_{jk}\right|=1 \tag{6}$$

Definition 2. Scene Match (S.M.)

For a specific verification set scene x_i, the training set scene x_j with the smallest weighted Euclidean distance is defined as "Scene Match" in equation (7).

$$S.M.=\min\{d_{ij}\} \tag{7}$$

Definition 3. Scene Hit (S.H.)

When the weighted Euclidean distance under scene match is not greater than 0.5 as in equation (8), it is regarded as a performance achievement, which is defined as "Scene Hit".

$$min\left\{d_{ij}\right\} \leq 0.5 \tag{8}$$

In a special case, when the weighted Euclidean distance under scene match is 0 as in equation (9), it is considered as "Complete Scene Hit".

$$min\left\{d_{ij}\right\} = 0 \tag{9}$$

4.3. Simulation Results

The simulations times are 1 million, and the total simulation duration is 12'23". The simulation results are shown in Table 2.

Table 2. Simulation Results

ep.	S.M. Sim.	W.E.D.	C1	C2	C3	C4	C5	C6	C7	C8
11	438 753	0.00	0	0	0	0	0	0	0	0
12	561 814	0.32	0	0	0	0	0	1	0	0
13	159 193	0.00	0	0	0	0	0	0	0	0
14	958 276	0.55	1	0	0	0	0	1	0	0
15	982 063	0.22	0	0	0	0	1	0	0	0
16*	295 987	0.71	0	1	1	1	1	0	1	0
...	...	...	...	...	...	...	...	...	...	...
62	819 082	0.32	0	0	1	0	0	0	0	0

In Table 2, episodes with asterisks are episodes that are not trained in the training set, including episodes such as past reviews, festival wishes etc. that are not related to the office diet and should be removed when doing performance metrics. The weighted Euclidean distance with underlined is S.H., and the performance metrics are shown in Table 3.

Table 3. Performance Metrics

	S.H. Rate	W.E.D. Mean	W.E.D. Dev.
Verification Set 52 eps	59.62%	0.444	0.24
NOT Include Outer Chapter 33 eps	84.85%	0.327	0.21

Removing the outer chapters, the simulation results is 84.85% hit rate, which can reflect certain academic value and commercial value. It can be inferred that a higher hit rate simulation result will be obtained if the scope of the training set is expanded or the producer's strategic intention is known in advance. .

5. Conclusion

This paper proposes a methodology of implementing creative support systems for Internet content creation. With the help of this method and its instance model, Internet content creation breaks the existing human cognitive boundaries and can achieve continuous output of high-level creative ideas. This methodology has a certain application value and contributions includes below:

1) In academic research, this paper proposes a method of constructing CSS model for Internet content creation, which fills in the blank of the intersection of creativity techniques and Internet content creation;
2) In practical applications, it provides a new development idea for the creation of Internet short video content, providing new tool for improving core competitiveness and entry barriers.

The current limitations are mainly reflected in the following 2 aspects: There are many manual interventions in this project, that is technical implementation and verification needs to be carried out from the analysis of specific industry data, modeling and construction of CSS systems. This is not easy to commercialize due to the process requires the participation of professionals who understand the data science and also be familiar with the specific business; Secondly, it does not support visual operations. The user experience of the command line interface is poor, and the original report needs to be written by script to preprocess.

In response to the limitations above, the major tasks in the future are:

1) Combining with machine learning technique, upgrading to a multi-agent design system to adapt to complex design tasks and improving the reuse of design resources;

2) Packaging the model as a web application that can be commercialized and improve user experience.

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