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A Creative Computing Approach to Film-story Creation: A Proposed Theoretical Framework

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Abstract: The film industry is currently witnessing a severe shortage of good stories and a decline in storytelling art. Meanwhile, creative computing has been employed successfully in the humanities, especially in the fields of art. Seeing the similarities between the process of film-story creation and that of creative computing, we propose a theoretical framework across the two domains, where the exploratory, the combinational and the transformational rules are jointly utilized to generate new ideas and provide potential options in film-story creation. The framework consists of a film knowledge library, a creative computing system, an evaluation model and an output module. The combination of creative computing and film story creation not only helps to produce novel storylines, shorten the creation cycle, and speed up film industry, but also contributes to the novelty and specificity of interdisciplinary studies.

Keywords: Creative computing, film-story creation, creativity rules, automatic generation, human-like scriptwriting.

1 Introduction

Throughout the history of film development, it is the scriptwriters′ exploration in various aspects like story structure, style, theme, and emotions that inspires the production of film stories and then many classic works. This kind of production is heavily dependent on the inspiration of scriptwriters. It is observed that there are many research findings around the world that serve as the theoretical models for story creation. The monomyth, or say, the fundamental structure of storytelling[1, 2], has been a much-preferred and much-copied template among the script-writers in Hollywood for years, generally deemed as the archetypal pattern in film-making. Among the related studies, Millard[3] emphasizes the influence of the visual story on the story creation, whereas O′Connor and Jackson[4] consider the historical and cultural elements are the crucial components of a story. Wei[5] argues that the socially omnipresent moralism determines how a story is constructed. He[6] explores the spatial structure in story creation. Yang[7] generalizes the relationship between film narration and language convention. All these theories, though essential constituents of film-story creation knowledge to some degree, lead to the production of more stereotypical film stories.

The film industry currently lacks a good storytelling line, and the display level of script art is insufficient[8]. It is getting more and more difficult to meet the constantly updated needs of the audience. There is an urgent need to seek out in film-story creation. In recent years, the rapid development of computing, more specifically, creative computing and artificial intelligence technology, is making it possible that computing becomes an indispensable assistance for, or even a substitution for, human brain in terms of knowledge-creating works. Interdisciplinary exploration always leads to innovative ideas for both products and services. The combination of creative computing and film story creation not only helps to generate novel storylines, shorten the creation cycle, and speed up film industry, but also contributes to the novelty and specificity of interdisciplinary studies.

2 Creative computing and its application

Computing is defined as any goal-oriented activity requiring, benefiting from, or creating computers[9]. It includes “designing and building hardware and soft-ware systems for a wide range of purposes; processing, structuring, and managing various kinds of information; doing scientific studies using computers; making computer systems behave intelligently; creating and using communications and entertainment media; finding and gathering information relevant to any particular purpose, and so on”[9]. This endless list implies vast possibilities of computing.

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Generally speaking, computing is usually considered rigid, for computers can do nothing but implement human′s orders. However, there is still room for computing to be more creative.

The philosophical basis of computer science justifies the creativity of computing. Wegner[10] explores ramifications of four influential definitions of computer science and argues that computer science was dominated by empirical research paradigms in the 1950s, by mathematical research paradigms in the 1960s and by engineering oriented paradigms in the 1970s, and defines computer science as "in part a scientific discipline concerned with the empirical study of a class of phenomena, in part a mathematical discipline concerned with the formal properties of certain classes of abstract structures, and in part a technological discipline concerned with the cost-effective design and construction of commercially and socially valuable products". Taking Wegner′s account, Eden[11] explores the philosophical roots and concludes there are three distinct sets of received beliefs or paradigms within computer science:

1) The rationalist paradigm, common among theoretical computer scientists, defines computer science as a branch of mathematics, treats programs on a par with mathematical objects, and seeks certain, a priori knowledge about their "correctness" by means of deductive reasoning.

2) The technocratic paradigm, promulgated mainly by software engineers, defines computing as an engineering discipline, treats programs as mere data, and seeks probable, a posteriori knowledge about their reliability empirically using testing suites.

3) The scientific paradigm, prevalent in the branches of artificial intelligence, defines computer science as a natural (empirical) science, takes programs to be entities on a par with mental processes, and seeks a priori and a posteriori knowledge about them by combining formal deduction and scientific experimentation.

These paradigms provide a philosophical basis for the study of the methodology, ontology and epistemology of computing, by treating it as either a branch of mathematics, or an engineering discipline, or a natural science. To figure out what kind of tool is helpful for achieving creativity in the field of computing, Hugill and Yang[12] combine three main components of computing (i.e., hardware, software and communications) with these paradigms. They first argue that the rationalist and scientific paradigms are somewhat adverse to creativity because of the rigor and preciseness of mathematics and science while the technocratic paradigm is flexible and therefore creative. Then they assert that hardware and communications develop under mathematical and physical laws, hence there is little room for creativity, while software always involves some degree of creativity. They therefore claim that creative computing aims to develop and improve in terms of software programs[12].

The nature of software verifies the creativity of computing. Art is traditionally regarded as creative. Hugill and Yang[12] make a comparison of the general process of music composition with that of software engineering. To compose a piece of melody always begins with some inner or outer motivation of a composer. That is, the composer has to or would like to do such a job. Then the composer may contemplate and determine how to formulate this plan, including the instrumentation, duration, context, etc. Afterwards, the composer turns to the creation of the work, based on the motivation and following the plan. When finished, the composition is about to be disseminated, and get revised on account of the audiences′ opinions. Likewise, software is always developed for certain purposes. Before a proper software product is developed, the main functionality of the software needs to be defined according to the requirements of the end-users. The general architecture of the software and the system platform (both hardware and software) will be drafted to meet the demands. The detailed structure of the software is then designed and programmed in accordance with the proposed specifications. Upon completion, the software needs to be evaluated by the end-users, who may require bug fixing and further functional updates[12]. The astonishing similarities between music composition and software engineering imply the capabilities and possibilities of computing to be creative. In fact, the creativity of computing has become a certainty, with the appearance and development of creative computing and recent findings in relevant areas.

Creative computing began to take its shape recently. Anchored in interdisciplinary knowledge combination, creative computing is designed to support creativity issues, participate in creative processes and solve relevant problems in various domains with computing science and the associated technologies. In other words, creative computing, as Hugill and Yang argue, "seeks to reconcile the objective precision of computer systems (mathesis) with the subjective ambiguity of human creativity (aesthesis)" [12]. Although the form of creative computing is to some degree restricted to software programs as has been argued above, the field where it is employed is however not restrictive. Creative computing-based research in vast interdisciplinary domains has been conducted by scholars worldwide and facilitated innovations in both science and humanities.

In humanities, especially in the fields of art, creative computing not only generates innovative ideas but also inspires artists to innovate artistic products[13]. The Sony Computer Science Laboratories in Paris have developed flow machines, the algorithms for music making, which generate music autonomously or in collaboration with human artists. In the fields of literature and journalism, researchers at the Future University Hakodate in Japan, with artificial intelligence, have generated a short story shortlisted for the Hoshi Shinichi Literature Award. The

Centre for Creative Computing in Bath Spa University in UK has developed a digital drama application system and a poetry analysis platform. The Center for Speech and Language Technologies of Tsinghua University in China gives "birth" to Weiwei, a Chinese poem generating robot, which has passed the turing test and the judgment of the scholars in relevant fields from the Chinese Academy of Social Sciences. Dreamwriter, developed with the algorithms for journalistic writing by Tencent, successfully generates news scripts automatically and finishes instantaneous output analysis. For visual arts, Google released an image generating software Deep Dream, using a convolutional neural network to find and enhance patterns in images via algorithmic pareidolia to create a dream-like hallucinogenic appearance. The Dwango Artificial Intelligence Laboratory in Japan starts to conduct experiments with an animation program that learns via artificial intelligence. In the area of education, a current example is a newly proposed creative inspiration model, which assists people to probe into their potentialities and provides suggestions for further improvement[13]. Besides, in recent years, automated game design has become a cutting-edge challenge in computational creativity research. Video games called "killer apps" showcase computer creativity. They are able to provide players with a large number of challenging projects, and also require them to work together in creative ways to solve problems[14].

Admittedly, young as the discipline of creative computing is, the creativity theories have been widely applied to practice. Through thinking across different disciplines, Boden[15] proposes three kinds of creativity, namely combinational, exploratory, and transformational creativity. Having observed Boden′s idea is more operable for creative computing, Wang and Yang[16] explain the three kinds of creativity further. Combinational creativity refers to combining familiar ideas to produce unfamiliar ones, which is achieved by making associations between ideas. Transformational creativity is a kind of deeper creativity, which is to discover possibilities within a new conceptual space through transforming the old one by altering one or more of its defining dimensions. Exploratory creativity inquiries into the possibilities within the culturally accepted style of thinking, or conceptual space, and discovers both the potential and the restrictions of the space.

A flexible application of the creativity rules in film-story creation may provide an effective solution to the existing problems and further testify to the value of cross disciplinary knowledge fusion.

3 Innovation in film-story creation

Film-story creation demands innovation. At present, representative research has all focused on the methods for creating film story, each concerning different aspects of creativity. Schamus holds that stories in a script are seemingly standardized products from an assembly line in a "narrative" factory, but are understood in different ways by different audiences once the "products" go on the market. The storyteller makes the story, the audience interpret the plot and structure from their own perspectives because of their unique personal life experience. Therefore, Schamus believes that the scriptwriter is supposed to make a balance between necessary creativity and following the prototype[17]. Hogan[18] expands the horizon of film-story creation research. From the perspective of affective narratology, Hogan regards story creation as a systemized result of the development of human emotion system, and to study story creation is, in essence, to study the emotional changes of the characters and the working mechanism of the emotion system of the audience in interpreting the story[18]. Therefore, the research and practice of film-story innovation may centre on the emotion elements of the film story. Vogler and McKenna[19] introduce some techniques for the creative construction of the story, character and theme. Richardson[20] explicates the creative progression of storylines from the perspective of narratology. Li[21] figures out that the story structure should better not be confined to a standardized narrative model. Shan[22] studies film creation and creativity under the principal commercial system. Li[23], from another perspective, probes into the initiative of film makers, revealing that the film maker′s perception of the narrative methods has great influence on film-story creation.

Among the research above, strategies for film-story innovation have come up through updating of the macro-structure of the film-story and modulation of the micro-elements. However, the core of innovation is relatively stereotyped, such as innovation only for the screen effect, or only for the audience′s moralism and its expectations. These innovations rely to a large extent on the inspiration of the film creators themselves, their perception of creative techniques, and their flexible use of film creation skills. However, it is undeniable that the vast diversity and fast change of the world nowadays greatly challenge the knowledge reserves and analytical capacities of human brain. A comprehensive analysis of the construction of film stories to seek out more efficient and powerful means to film creation is an inevitable choice for the scriptwriters to solve the existing problem. It is necessary to get rid of the absolute dependence on the human brain and throw our eyes upon computing, where noticeable progress is already achieved.

In the area of story creation, deviating from traditional story generation procedures, the plan-and-write hierarchical generation framework[24] takes a title as input and challenges open-domain story generation. Adopting an incremental encoding scheme, the model[25] may generate a story ending with commonsense. However, it only uses a language model to create a story, which lacks user guidance. A reward-shaping technique[26] provides intermediate rewards that are propagated back to the pre-trained language model to guide the model toward a given goal. And hierarchical neural story generation[27] explores creative systems that can build coherent and fluent passages about a certain topic. Coarse-to-fine models[28] are applied for creating narrative texts of several hundred words, and updated models are developed to decompose stories by abstracting over actions and entities.

As for visual storytelling, Microsoft proposes the first sequential vision-to-language dataset and applies it to the task of visual storytelling[29]. To overcome the limitations of automatic metrics and hand-crafted rewards, the adversarial reward learning framework[30] is trained to learn an implicit reward function from human demonstrations, and then optimize policy search with the learned reward function. The hierarchically structured reinforcement learning approach[31] is adopted to generate coherent multi-sentence stories for the visual storytelling task. This method uses a two-layer hierarchical decoder to generate the story of a given image sequence. A neural narrative generation system[32] interacts with humans to create stories. The system realizes the production of high-quality and easy-to-understand stories through human-computer interaction at different levels.

To make an adequate survey of the innovation of storytelling, it is necessary to focus our attention not only on film itself but also to some other areas. Digital games seem to be a cutting-edge subject, in which innovative means of generating characters, situations and other elements in a story have been adopted extensively. For example, an environment-specific semantic information editor is defined, which can be applied to using the specific location obtained from the real world. Users can insert text information related to the characters' real position in the real world during navigation in the virtual environment of the game[33]. Patel et al.[34] propose the use of a game theoretic based learning rule called "fictitious play" for improving the behavior of the computer game bots, which makes the game less predictable and more enjoyable. Zhou[35], from a more broad perspective, summarizes three main models by which AI narration is applied into film-story and game-story generation, namely 1) AI recognizes the story and its emotion patterns and hence helps and assesses the narration, 2) AI generates the story in a static state, and 3) AI generates the story dynamically and interactively[35]. Game stories and film stories are similar in nature and in practice. Innovative ideas realized in digital games can be borrowed to film-story creation, on one hand, to increase closer bilateral interaction between audiences and film characters, thus producing better market effect; on the other hand, cross-field borrowing may trigger more innovation in both areas.

Although the story initially attempted by computing at present is not totally satisfactory logically and thematically, it provides a new approach and technical means for film innovation, and it is feasible to solve some long-existing problems. There is still vast space to explore in the application of computing in film-story creation. Thus, we intend to propose a theoretical framework across the two domains of creative computing and film-story creation, where the exploratory, the combinational and the transformational rules are jointly utilized to inspire new ideas and provide potential options in film-story creation.

4 A creative computing approach to film-story creation

4.1 A proposed film-story creation platform

A good way to understand how creative computing may be implemented into film-story construction is to figure out what happens to a scriptwriter when creating a new story. Generally, before a scriptwriter prepares to tell a story, detailed observation and long-time experience in real life are the musts so that the scriptwriter could accumulate vast materials in his/her mind. Once the scriptwriter decides to start a new story, the stored materials will be deliberately processed and integrated together into the storyline, with literary techniques being rules to guarantee the readability. Upon finishing the task, the scriptwriter would share the newborn story with editors, peer writers, potential audiences and the like, gather their opinions, and revise it until as many people as possible accept it. When the final draft is completed, it is time to get it published. Fig. 1 may help clarify this process.

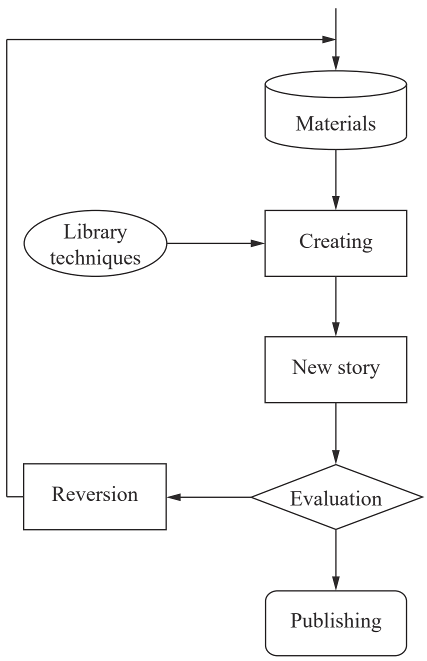

Fig. 1 Film-story creation process

Inspired by the path of scriptwriters′ composition of a film story, we intend to innovate the theories and methods of story construction by developing a film-story creation platform with the aid of creative computing. The platform consists of four modules: a film knowledge library, a creative computing system, an evaluation model and an output module, shown as below (see Fig. 2).

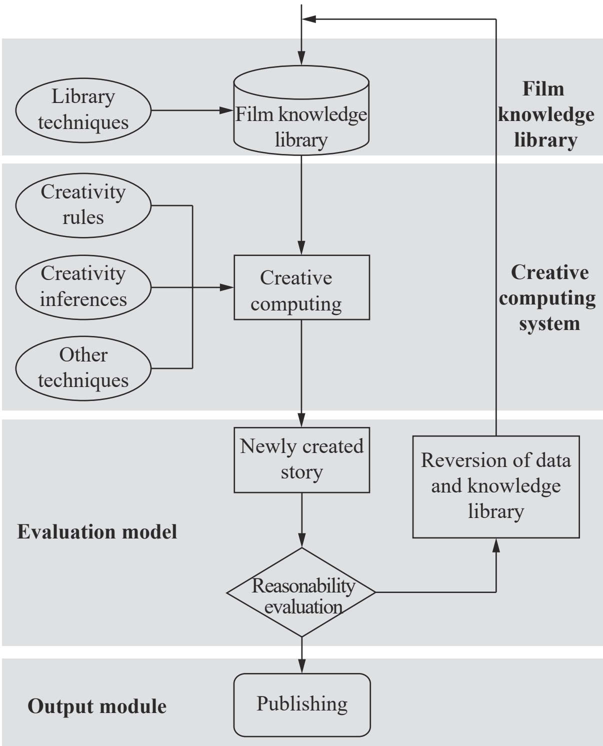

Fig. 2 A proposed film-story creation platform

1) The film knowledge library consists of a relevant information database and a scene database, examples from internet movie database (IMDB), which aims to provide materials for innovative film-story creation and data for theoretical research. Newly created film stories are also temporarily stored in the library and the evaluation index as well.

2) The creative computing system is developed for intelligently utilizing (such as merging, reorganizing, transforming) the materials in the film knowledge library to create new film-stories and innovate story construction theories and practice.

3) The evaluation model is structured for analyzing and justifying the reasonability of the newly created story to ensure the practicability of the final output and acceptability for the target audience.

4) The output module works for displaying the qualified story. If the evaluated story is deemed as reasonable, it then goes forward to the output module and meanwhile enriches and updates the film knowledge library. Otherwise, it goes back to previous modules for re-computing and re-generating.

4.2 Film knowledge library

As mentioned above, the source of film-story creation, the film knowledge library consists of four parts, namely, film scene database, relevant information database, newly created film stories, and the evaluation index.

1) Film scene database: It serves for the study on the strategy and method of film scene decomposition, scene parameterization, and plot analysis and annotation. The present project starts with this database: We first analyze the selected film scripts in it and decompose the stories into a series of scenes, and then quantitatively label each scene and assign it to the corresponding parameters. The contextual relevance of the storyline, the characters′ appropriateness for the scene and the criticality of the conversation are also the concern. Of the above steps, the step of parameterization is the key one.

The keywords “EXT.” and “INT.” are used to guide the scene conversion in the movie script. Therefore, we segment the scene according to the keywords. In addition, the corresponding values are given according to the sequence of scene occurrence.

The plot consists of a series of events. The basis of scenario analysis is event extraction. Character relationship is an important factor in plot analysis. The Att-BiLSTM model is used in relation extraction. The information of event extraction includes entity recognition and event type. Event type is abstracted as event classification, which uses keyword matching technology to classify events and get correct event classification. Entity recognition is concerned with people, time and place. We use a BIO tagging method to obtain data sets to train BiLSTM-CRF model. The basic idea of the model is to get a predicted label sequence $y=(y_1,y_2,\cdots,y_n)$ for each input $X=(x_1,x_2,\cdots,x_n)$, and define the predicted score as

$$s=(X,y)=\sum_{i=0}^{n}A_{y_i,y_{i+1}}+\sum_{i=1}^{n}P_iy_i \tag{1}$$

where P_i, y_i is the transfer probability of SoftMax output y_i at the i-th position, $A_{y_i,y_{i+1}}$ is the transfer probability of y_i, y_{i+1}.

2) Relevant information database: The information collected in this database includes film type information and information on film research, film reviews, film awards, etc., which serves for sorting the film data. We add annotations to the film data according to basic film types (such as romance, horror, modern epic, etc.). The information about film research, reviews, awards is collected with literature research methods and classified into different categories labeled with a set of semantic attributes quantitatively annotated. To obtain this kind of information, we use the technology of web crawlers to crawl IMDB, Douban and other movie collection websites.

3) Database of newly created film stories: New film stories are intelligently generated based on the creative computing approach proposed by the project and have been effectively evaluated by the evaluation model. They are temporarily stored in the separated storage space, and then transferred to the film scene database when the scenes are analyzed and decomposed. At the same time, the temporary storage space will be reclaimed. The associated information of newly created film stories will also be sorted and stored in the relevant information database.

With new film stories and associated information added as new data, the knowledge base is correspondingly updated. Knowledge base updating involves knowledge reasoning and knowledge fusion technology based on embedding. We use the way of reasoning to promote fusion: use TransE method to achieve the fusion of entities relationship, and then use entity embedding to calculate the similarity, such as the cosine similarity measure, to complete further entity alignment. The model of TransE is

$$f(h, r, t) = \| h + r - t \|_{L1/L2} \quad (2)$$

where h is head entity, r is relation, t is tail entity, $\| \cdot \|_{L1/L2}$ means $L1$ norm or $L2$ norm. The cosine similarity measure is

$$V = \cos(E_1, E_2) \quad (3)$$

where V is the similarity degrees, E_1 and E_2 represent two different entities, respectively.

4) Database of evaluation index: Through deep learning of the historical data about the information in film scene database and relevant information database, the evaluation index is proposed. Both the intelligent generation of new storylines and the rationality assessment of them are based on the evaluation index. The common metrics of text evaluation are bilingual evaluation understudy (BLEU), metric for evaluation of translation with explicit ordering (METEOR), recall-oriented understudy for gisting evaluation (ROUGE), consensus-based image description evaluation (CIDEr).

When storing data, we define data categories from the schema layer[36, 37]. As the preliminary study shows, the large-scale film knowledge library, which is established through language understanding and text analysis, automatic knowledge acquisition, storage, fusion and reasoning, is still being improved.

4.3 Creative computing system

Creative computing is the application of computer technologies to emulate, study, stimulate and enhance human creativity. To establish a film-story generating model by creative computing (with theories of AI or machine learning) is the core of intelligent film-story creation, which consists of two parts, namely, the intelligent generation of the text (film script) and the scene (multi-modal story). Therefore, providing a film information database has been set up for machine learning, the research and implementation of the intelligent generating model mainly includes the following two steps.

1) Intelligent text generation: It is based on the study of natural language processing techniques. In order to reduce the semantic gap in text learning according to the information provided by both the text and the corresponding scene, a transformed long short-term memory (LSTM) natural language processing model is utilized to perform text training. The model follows the basic structure of recurrent neural network (RNN) cyclic neural networks with scene annotations as the regular constraints so that it can generate new scripts with more logical contents in accordance with the film genre and key information of the input requirements.

2) Intelligent scene generation: Visual image fusion and generation techniques are employed in the scene generation. According to the storyline of the script newly generated in the previous step, we segment the text into scenarios along the corresponding storyline. Typical scenarios relevant to and fitting the script are retrieved from the database with the technique of semantic content retrieval. Then a deep generative adversarial network (GAN) with the ability of learning transfer is built up within the targeted semantic constraints. A new scene is finally generated after migration and fusion of semantic contents of the retrieved scenes.

Generally speaking, the creation of new storylines and scenes is realized in changing or integrating the existing film-story construction rules. The technical route of intelligent film-story creation is as follows.

To change the existing rules, first of all, we investigate the commonalities and specialties of the story construction types of representative films of major genres (the western, the horror, the musical) to figure out what roles the prototype story plays in film-story construction and how diverse the form and content of the prototype are presented. The existing story construction rules are modified and the storyline modules are innovated on the basis of the investigation. Then, guided by the theme and purpose of the to-be-created film-story, we propose the parameters of situations, characters, dialogues, music, scenery, etc. and analyze them accordingly. The relevant situations, characters, dialogues, music, scenery could be retrieved from the film knowledge library as the input information with the semantic content retrieving technique in the light of the former analysis.

Fig. 3 shows the route of intelligent acquisition of the input information for storyline construction. The needed information is kept in the database. The analysis of the above mentioned parameters could be acquired by semantic correlation analysis, and semantic segmentation coding of time-featured parameters is to be performed with RNN. Formulae (4) and (5) show the calculation in

RNN.

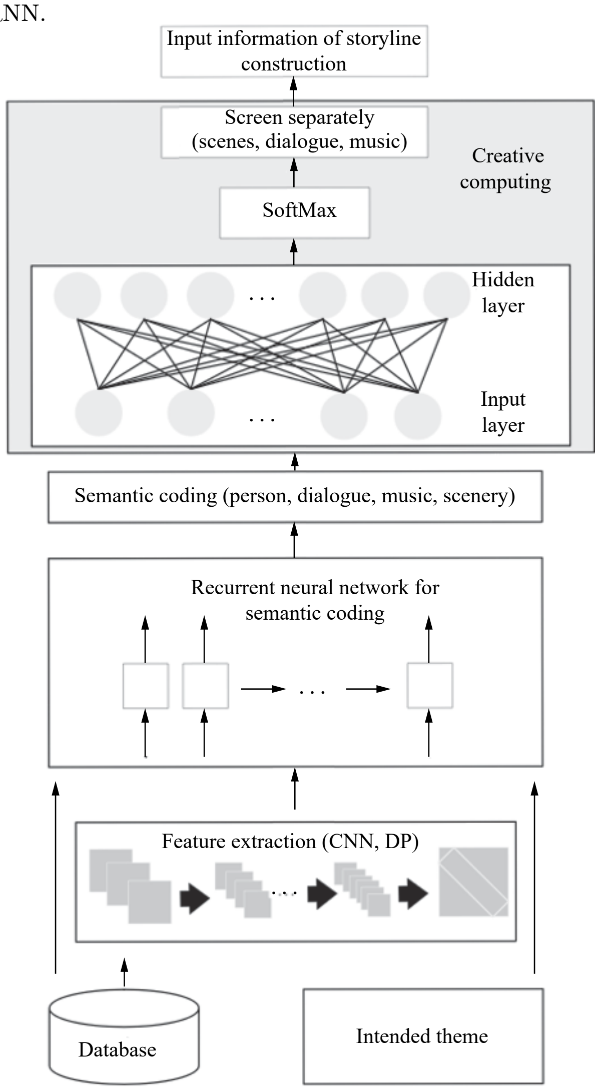

Fig. 3 Intelligent acquisition of input information for storyline construction

$$h\left(t\right) = \tanh(W_{xh}x_t + W_{hh}h_{t-1} + b_h) \tag{4}$$

$$y\left(t\right) = \text{sigmod}(W_{hy}h_t + b_y) \tag{5}$$

where $h(t)$ stands for the hidden layer state of the time step t (time step is represented by "t"), x_t and y_t for the input and output of the time step t, respectively, W_{ij} for the layer connection weight, b_i for the offset value, and tanh() and sigmod() are the optional activation functions. For example, the semantic coding for a scene starts with feature extraction to compress the data, and then RNN is used for semantic coding (for the shift of scenes is of temporal features). The semantic coding for a dialogue, however, directly starts with the RNN semantic coding without feature extraction. Afterwards, correlation analysis is performed for the encoded information. Finally, with the theme of the story to be generated semantically coded, we adopt the semantic retrieval method of the multi-layer neural network to analyze the coded information. The materials most relevant to the theme are justified by SoftMax function (6):

$$y_C = \frac{\mathrm{e}^{x_C}}{\sum_{d=1}^{C} \mathrm{e}^{x_d}} \tag{6}$$

where y_C stands for the output vector of C dimension, x_C stands for the input vector of C dimension, and the denominator of (6) is a regular term. What is finally worked out is the classification probability of the input x_C, which indicates what materials are most relevant to the theme in the semantic sense.

Then we go further to establish a deep generative adversarial model with the ability of transfer learning according to the targeted semantic constraints. The model is to achieve the transfer and combination of pictures and scenes according to the requirements of the context and to realize the innovation of the existing conceptual space. The deep generative adversarial model with the ability of transfer learning is shown in Fig. 4. The effect of the model to realize transfer and combination is quantitatively justified according to the probability of rationality of the picture-scene transfer and combination under the premise of the known contexts. The probability judgment is formalized as Formula (7):

$$P\left(x, y|z\right) > Q \tag{7}$$

where Q stands for the acceptable lower limit of probability x, y given z, where x represents the picture, y represents the scene, and z represents the context. The specific issues around the construction of the deep generative adversarial model with the ability of transfer learning, such as the characteristics of transfer learning, where and how deep neural network is fused with transfer learning still need further discussion. Meanwhile, the research of natural language processing and semantic content-based image retrieval is carried out to realize the matching and fusion of dialogues and scenes, and then we calculate the emotion index after the fusion of different scenes by interpreting the data concerning the presentation of emotions with the emotional interaction theory.

According to the theory of isomorphism, all films share the same or similar systematic structures. Therefore, there are isomorphic scenes in different types of films. It is necessary to study the typicality and differences of the isomorphic scenes as well as the flexibility of the attribution of these scenes in different film types. When a scene typical for a certain type of film hybridizes into another type of film, a qualitative change may occur, and the original storyline will thus be reversed, according to the fusion deduction theory. A deep transfer and generation model is required to input the results of the com-

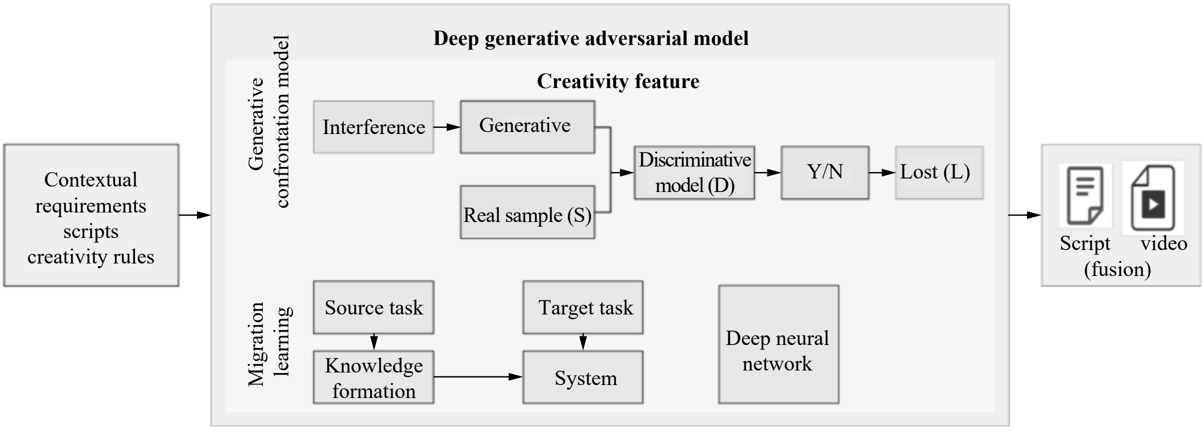

Fig. 4 Deep generative adversarial model with the ability of learning transfer

bination of the scenes from different types of films. The integration of heterogeneous concepts leads to the innovation of film types.

The visual image is another important component of the film story. A large number of classic Oscar films have provided not only wonderful story contents but also fascinating visual experiences. Therefore, it is of immeasurable significance if the visual version of the newly created film story could be generated directly by retrieving and transferring the existing scenes in the database. Two major procedures are involved: the semantic-content-based image retrieval and the retrieved-image-based picture fusion. Thus, the research concerned with the visual version production starts with the content-based image retrieval, which intends to retrieve the relevant images from the scene database to match the selected semantic content of the new script. Prior to this, what needs finishing first is to segment the script into smaller units, each corresponding to one scene of the new script. The segmentation is manually conducted and the selected content in the segmented units is used as the semantic guidance for the image retrieval from the database.

Since the present research is still a preliminary trial in intelligent film story creation, it initially aims to generate a simplified visual version of the newly created film story without considering the fine continuity of the scenes.

With the visual images relevant to the target content retrieved from the database, it is necessary to carry out an exploration of the fusion and generation of new visual images which fit the target content of the new story. Recently, the development of convolutional neural networks (CNN), combined with the generative adversarial network (GAN), has brought great improvements to image conversion tasks, including image super-resolution, denoising, semantic segmentation, automatic complementation, etc.[38, 39]. GAN is a new idea in machine learning. It is produced by two models together: one focuses on generating samples, and the other focuses on discriminating between true and false. The kernel concept is to continually modify the generative model and make the simulated probability model as close as possible to the real probability model. There is Word2vec technology in natural language processing to make the analogy. For instance, v (“woman”) − v (“man”) + v (“king”) = v (“queen”), that is, the attribute of “woman” minus that of “man” and then plus that of “king” equals “queen”. It is like adding the features of “woman” to “king”, and correspondingly “king” turns to be “queen”. GAN is also able to complete the analogy. As shown in Fig. 5 below, a male wearing sunglasses, minus the gender attribute “male”, adding the gender attribute “female”, becomes a female sunglasses wearer.

Other variant networks of GAN also function for the present project. For example, the perceptual adversarial network (PAN) can remove rain marks and generate semantic markers as shown in Fig. 6 below. Different new scripts require completely different variations of the scenes retrieved from the material database, which poses a great challenge to the use of GAN to achieve image generation. However, “GAN+Boundary conditions” is useful to explore the transfer learning of the semantic content of the image data by the generative model. Therefore, the innovation of the story structure module is realizable by a reasonable combination of the film prototype story model with the academy award – winning films story construction model and corresponding adjustment of the transfer and generation rules. For example, a new film can be created when some of the scenes in one existing film are replaced with the selected typical scenes in other existing films. And the fusion of heterogeneous film types, i.e., combining creatively the scenes in different film types leads to diversity and originality of film types.

4.4 Evaluation model

Reinforcement learning, also known as evaluation learning, is an important method of machine learning, which has been applied in many fields such as intelligent robot controlling and predictive analytics. Therefore, a deep reinforcement learning network is to be explored to

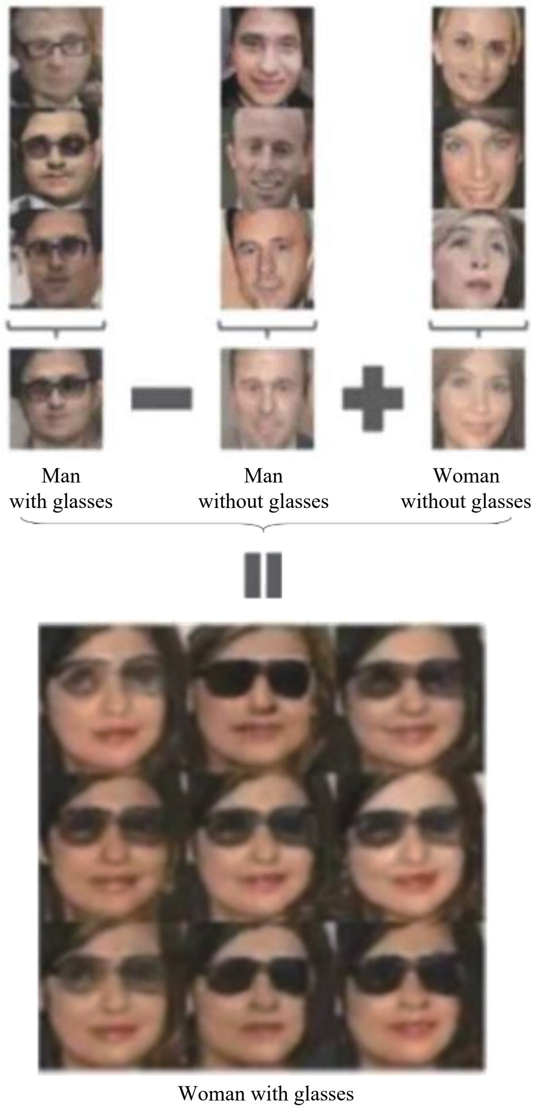

Fig. 5 Image analogy and substitution by GAN

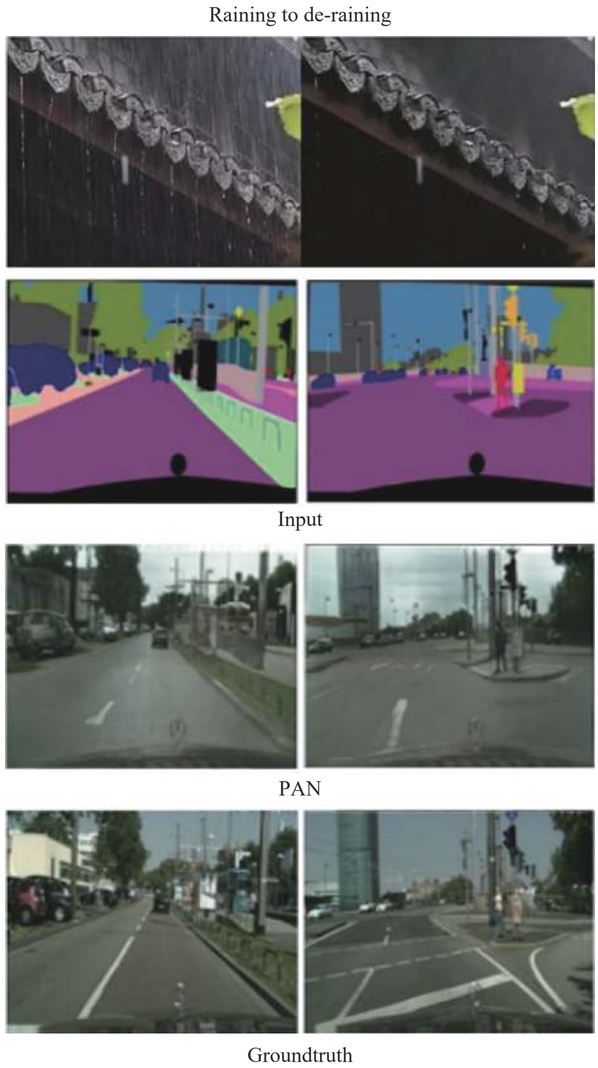

Fig. 6 PAN's function of semantic markers generation

assess the reasonability and acceptability of the film-story content. The algorithm of deep reinforcement learning could be considered as the brain of an intelligent agent, containing an actor module and a critic module (Fig. 7).

The actor module is the brain's actuator that inputs the external situation s and then outputs an action a. The critic module acts as the brain's values system, making self-adjustment based on the historical information and response r, and then affecting the entire actor module. This actor-critic approach simulates humans' behavior. Human beings also act under the guidance of their own values and instincts, and the values constantly change under the influence of increased experience. Therefore, value assessment is the core of reinforcement learning. The computing expressions of the evaluation indicators such as the logic indicator and validity indicator of the storylines are needed as the basis for assessing the value of reinforcement learning structure of the film

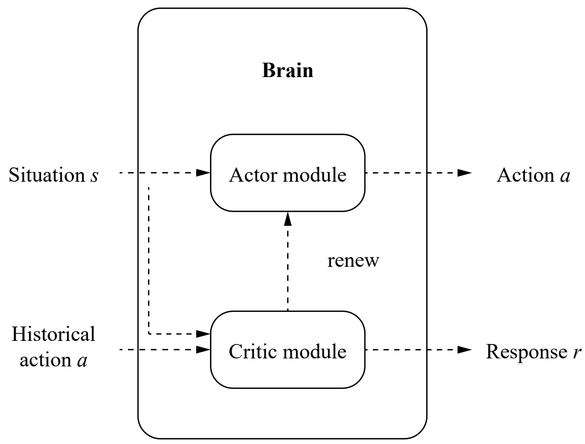

Fig. 7 Actor-critic model

story, so that the reasonability and practicality of the generated storylines is quantitatively analyzed and then the intelligent generation module receives feedback and then makes the corresponding adjustment. The validity of the newly created story is mainly judged by a comparison with the structure of the films of the same type in the database. Therefore, the deep canonical correlation analysis (Deep CCA) is to be used to extract the relevant semantic features of the storyline to be tested and the reference data in the database. They are both used as the inputs for each evaluation indicator. In fact, the story text and picture generating part mentioned before corresponds to the intelligent agent/action module in the reinforcement learning. If a story is evaluated as unreasonable by the evaluation system, feedback is given to the intelligent story-content generating model. A re-adjustment of the generating model is needed for a higher quality story with improved evaluation results. If the evaluation result is good, the intelligent story-content generating model would respond to the scene pictures, and then the pictures would be connected into a whole as an output video together with the text, further supplementing the film knowledge library.

4.5 Output module

The module is for displaying the final work. What has been evaluated as qualified is to be finally shown as a story and film in the output module.

5 Creativity in creative computing-based film-story creation

The data in the film knowledge library is utilized not only as the source of new film creation but also for exploring the relations between the film-story creation theory and methodology, and the social assessments and influences of the film so that we objectively interpret how the archetypal pattern in film making functions for the story construction of the selected films. This task forms the basis of the creative operating mechanism of the creative computing system.

The creative computing system, as an operational construction system for innovating film-story creation by means of creative computing, serves for story writing as well as for verifying the feasibility of interdisciplinary research on creative computing and film art. Among the above four modules, the core lies in the creative computing system, where three kinds of creativity jointly work as the guiding principle in the new story creation.

1) Combinational creativity is manifested in creatively utilizing isomorphic scenes in the films of the same type. We employ isomorphism to compare the parameters within isomorphic scenes in the selected films, filter out unique and novel situations, characters and dialogues, embed the filtered segments into a new film, and combine them with the residue of the new film. The mechanism lies in defamiliarizing the familiar elements to achieve creativity. For instance, when isomorphic scenes in a series of crime films are compared and contrasted, the most typical ones among them can be selected, where such parameters as situations, characters, or dialogues display unique features, to fit into a new film as required.

2) Transformational creativity in film-story creation is achieved by altering and reshaping the defining dimensions of each type of film. The inspiration is obtained by an exploration of the defining dimensions of another type of film which is ordinarily regarded as an unrelated type. For instance, if the defining features of a typical disaster film are abstracted and hybridized with those of a romance or a detective film, a transformed novel type of film can be generated.

3) Exploratory creativity leads us to deeply exploit the existing rules of each type of film and discover both the implicit or unvisited part and the potential and restrictions in applying the rules to film-story creation. We employ the concept of topology to delve into the universality (and, meanwhile, the individuality) of the story creation model of different types of film as well as the function of the prototype. Topology is concerned with the properties of space that are preserved under continuous deformations, thus furthering the research in the given area to find out new routes to the creativity predicament.

To analyze the newly created stories from an objective rather than subjective perspective, we specify a series of evaluation parameters to examine the theories and practice on creative film-story construction and guarantee the originality and applicability of the newly created stories and the acceptability of the products among target audiences.

The parameters are formulated on the basis of the criteria proposed by Dean et al.[40]: novelty (with the sub-dimensions of originality and paradigm relatedness), workability (with the sub-dimensions of acceptability and implementability), relevance (with the sub-dimensions of applicability and effectiveness) and specificity (with the sub-dimensions of implicational explicitness, completeness and clarity). The creativity attributes are redefined and re-catalogued by Yang et al.[41]: novelty (with the sub-dimensions of originality and paradigm relatedness), usefulness (with the sub-dimensions of relevance, acceptability, implementability, implicational explicitness and completeness) and surprising (with the sub-dimensions of unexpectedness and unusualness to assess creativity in solution and product ideas. The current research concentrates on a 3-perspective evaluation standard and simplifies the criteria; that is, from the perspectives of the researcher on creativity, the producer (scriptwriter), and the receiver (audience). They are the major roles in the whole process of film-story creation and the major concern of the present study. Since each party has distinct targets and requirements, the starting point of the creativity researcher is to achieve novelty, the focus of the scriptwriter is feasibility, and for the audiences, acceptability should be put at the first place. The evaluation parameters selected for the research are originality, applicability and acceptability, which corresponds to and proceeds through the four steps of artistic creation (film-story creation in the present study): motivation, formulation, creation and dissemination/revision; and 2) software engineering (film-story creation platform development in the present study): user requirements, system design, coding and operation/evolution depicted by Hugill and Yang[12]. Fig. 8 presents the relational structure to show how the parameters are applied to the different steps of film-story creation and film-story creation platform development. What should be pointed out is Fig. 8 only demonstrates the most direct linkage between the three parameters and the four steps. Each parameter predominates in one step or two steps, but may also be a guiding principle of the creative work in other steps. For instance, it cannot be denied that the parameter of originality affects the steps of formulation and creation, as well as the steps of system design and coding, but it is the step of motivation and use requirements that are the most directly affected domains.

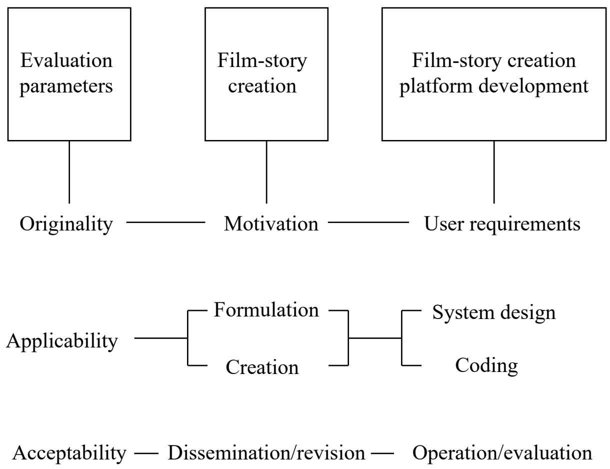

Fig. 8 Relational structure of evaluation parameters

6 Conclusions

To realize film story innovation, it is necessary to get rid of the absolute dependence on the human brain, which can also solve such problems as long cycles and high cost of film creation. We have focused in this paper on the automatic generation of film stories, and proposed a set of exploratory, transferable and combinatorial theoretical framework, combining creative computing with film story generation to realize the process of "human-like" scriptwriting.

First, we use scene segmentation, entity extraction, and event extraction technology to prepare data for story generation, and use entity similarity and the TransE method to achieve the fusion of entities and entities relationship.

Second, we put forward the implementation technology scheme for processing text and scene data respectively. Following the rules of innovative storyline generation, an implementation scheme is proposed for constructing storylines based on the intelligent acquisition of input information. In the aspect of scene data processing, a deep generative antagonism model with migration ability is proposed under the guidance of migration and antagonism.

Third, we propose a self-evaluation scheme supported by the theory of reinforcement learning. In general, we have built a set of automatic generation and evaluation systems for film story generation with innovative computing methods including exploration, innovation, and migration.

To integrate creative computing with film-story creation is deeply significant and necessary in various domains and disciplines. On the one hand, for creative computing, the integration is to expand the range of research and provide context for interdisciplinary study between natural sciences and humanities. For the film industry, on the other hand, the integration is to provide technical support for the creativity of film art and help scriptwriters with wider selection of story constructing methods in creative writing. The employment of innovative scientific techniques to the analysis and creation of film stories links many other different disciplines and theoretical analysis methods, spanning literature, narratology, psychology, pop culture apart from computer science and film making. The proposed framework, established on the solid research basis of our previous publications and patents in text generation, focuses on the work of automatic script generation. Future work will concentrate on the research in the field of the image generation, with a prospect of achieving automatic film generation.

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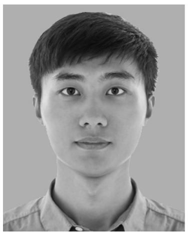

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