Motif Definition and Classification to Structure Non-linear Plots and to Control the Narrative Flow in Interactive Dramas

Knut Hartmann, Sandra Hartmann, and Matthias Feustel

Department of Simulation and Graphics ,
Otto-von-Guericke University of Magdeburg,
Universitätsplatz 2, D-39106 Magdeburg, Germany
Knut.Hartmann@isg.cs.uni-magdeburg.de,
Sandra.Hartmann@web.de, Matthias.Feustel@gmx.de

Abstract. This paper presents a visual editor which supports authors to define the narrative macrostructure of non-linear interactive dramas. This authoring tool was used to represent Propp's narrative macrostructure of Russian fairy tales in non-linear plot graphs. Moreover, Propp's thorough characterization of basic narrative constituents by explanations, discussions and examples of their different realizations in his corpus is utilized to construct an automatic classification model. A semi-automatic classification supports (i) authors to associate new scenes with basic narrative constituents and (ii) players to control the narrative flow in the story engine. For the latter task, the selection of an appropriate plot element and behavioral pattern within the dialog model in response to player interactions is controlled by similarities between stimuli and known realizations of basic narrative constituents or behavioral patterns. This approach tackles the main challenge of interactive drama — *to balance interactivity and storyness.*

Keywords: Interactive Drama, Non-linear Plots, Authoring Tools, Propp Functions, Motifs, Document Classification, WordNet, Narrative Control, ChatterBots.

1 Introduction

The research in interactive drama focuses on the development of formalisms and techniques to select or generate interesting plot structures which integrate player interactions coherently. As authors need a profound knowledge of internal data structure of these prototypical story engines there are just a few tools available which support a collaborative authoring, (re-)structuring, and evaluation of interactive dramas by non-programmers.

This work presents an authoring tool to define and (re-)structure non-linear plot structures and proposes a story engine, both based on the notion of narrative macrostructures. The paper is organized as follows: Sec. 2 introduces the concept of narrative macrostructures. Sec. 3 presents the architecture and the individual components of our narrative authoring system. Sec. 4 discusses related work and Sec. 5 summarizes the contributions of our work.

G. Subsol (Ed.): VS 2005, LNCS 3805, pp. 158–167, 2005.

2 Narrative Macrostructures

This paper employs Propp's analysis [15] of typical plot patterns and their dependencies in a specific narrative genre. However, authors are not restricted to use this specific inventory of plot patterns.

Propp's analysis of basic narrative constituents (*functions*) is based on two abstractions:

(i) a classification of the *dramatis personae* according to their *roles* and
(ii) an evaluation of actions with respect to common effects and according to their positions within the story.

Using this approach analysts are able to extract the *macrostructure* (*deep structure*) for a given story or plot (*surface structure*). To avoid the general and ambiguous term *function*, we will refer with *motifs* to basic constituents of the deep structure (as used by Pike's [12] and Dundes' [4]) and with *scenes* or *plot elements* to basic narrative entities of the surface structure.

Propp claimed that the genre of Russian fairy tales could be defined through a small inventory of motifs which are arranged within two alternative sequences. Propp's concepts influenced research to analyze narratives with highly conventional set of roles and motifs (e.g., myths, or epics) and even other media (e.g., reality TV shows). Narrative macrostructures have also been proven to be a very useful framework for interactive dramas. However, most researchers argue that the inventory of motifs as well as their order have to be adapted for different narrative genres. Moreover, plot structures in interactive dramas have to integrate player interactions, therefore additional control mechanisms are required to ensure the coherency of non-linear plots.

In order to support the analysis of narratives, which employs the identification of plot elements and their motival classification, Propp provides a list of common motival *variants* and their prototypical realization.[1] Unfortunately, the motival analysis is both subjective and time-consuming, as the segmentation of the narrative into basic plot constituents and their motival classification involves a high amount of abstraction, transformation and comparison with the prototypical examples and variants. Moreover, assimilations between realizations of motifs complicate the analysis. Finally, different symbolic representations for Propp's motifs used within the Russian, English, and German versions of his book make it hard to discuss and share the results. However, Propp's detailed explanations, discussions and examples of different realizations of motifs can be exploited in order to construct an automatic classification model.

3 An Authoring Tool for Interactive Dramas

We developed an authoring toolkit to create and structure non-linear plots and an initial prototype of a story engine which both are based on narrative macrostructures. Fig. 1 presents the architecture of our narrative authoring tool.

The visual *plot editor* supports the definition of new motifs and their dependencies. Authors define the content of individual plot elements or scenes within the *content editor*. This process involves the assignment of scenes to motifs.

[1] Propp defined 31 motifs which frequently exhibit many variants (up to 25).

A semi-automatic classification of new scenes reduces the number of candidates which have to be considered by a human interpreter and helps to prevent incoherent classification through subjective decisions from independent human experts. Thus, more motifs and motival variants can be established without spoiling the classification process. Our authoring tool supports a collaborative story development: the overall plot structure and dependencies between plot elements, abstract scene descriptions or dialogs, sounds, and animations could be provided by specialized experts.

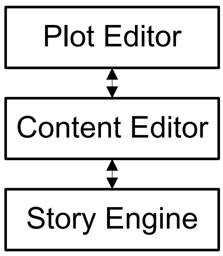

Fig. 1. Architecture

We also started to implement a *story engine*, which employs an automatic classification of player stimuli to control the narrative flow. However, this paper will mainly focus on the authoring toolkit.

The basic tasks in our narrative authoring tool comprises (i) the definition of new motifs and their arrangement within a non-linear plot, (ii) the specification of basic plot elements (scenes), (iii) the classification of scenes according to a given set of motifs, and (iv) the interpretation of player interactions within the story engine. All these tasks are described in separate sections.

3.1 Authoring Non-linear Plot Structures

The visual editor is used to define or select motifs and their causal or temporal dependencies in a *plot graph*. Our plot graph editor currently employs Propp's inventory of motifs. We defined positive and negative variants for Propp's motifs.[2] Fig. 2 presents the plot graph for an interactive drama in the fairy tale world. The branching in the subtree on the left side reflects the alternative motif sequences in Propp's formula:

$$ABC\uparrow DEFG\,\frac{HJIK\downarrow Pr-Rs^0\ L}{LMJNK\downarrow Pr-Rs}\ Q\ Ex\ TUW*$$

Note that the motifs where the story ends are visualized with thick borderlines. Authors can select the subset of motifs required for their plots and specify the dependencies between motifs interactively.

To simplify the user interface we designed a set of icons for Propp's motifs and display their textual descriptions in tool-tips. All icons follows 3 design principles:

1. a constant color-code is used to identify the roles of the dramatis personae throughout the motifs,
2. icons for positive and negative variants of motifs use the same visual elements in different colors,
3. icons for related motifs as often found in Propp's analysis reuse most of their visual elements to signal their relation.

Moreover, additional descriptions, variants, and examples of motifs establish a training set for the classification model. In the current system this information was extracted from Propp's seminal analysis.

[2] This comprises the following motifs: *beginning counteraction* C, *hero's reaction* E, *provision or receipt of a magical agent* F, *struggle* H, and *solution* N.

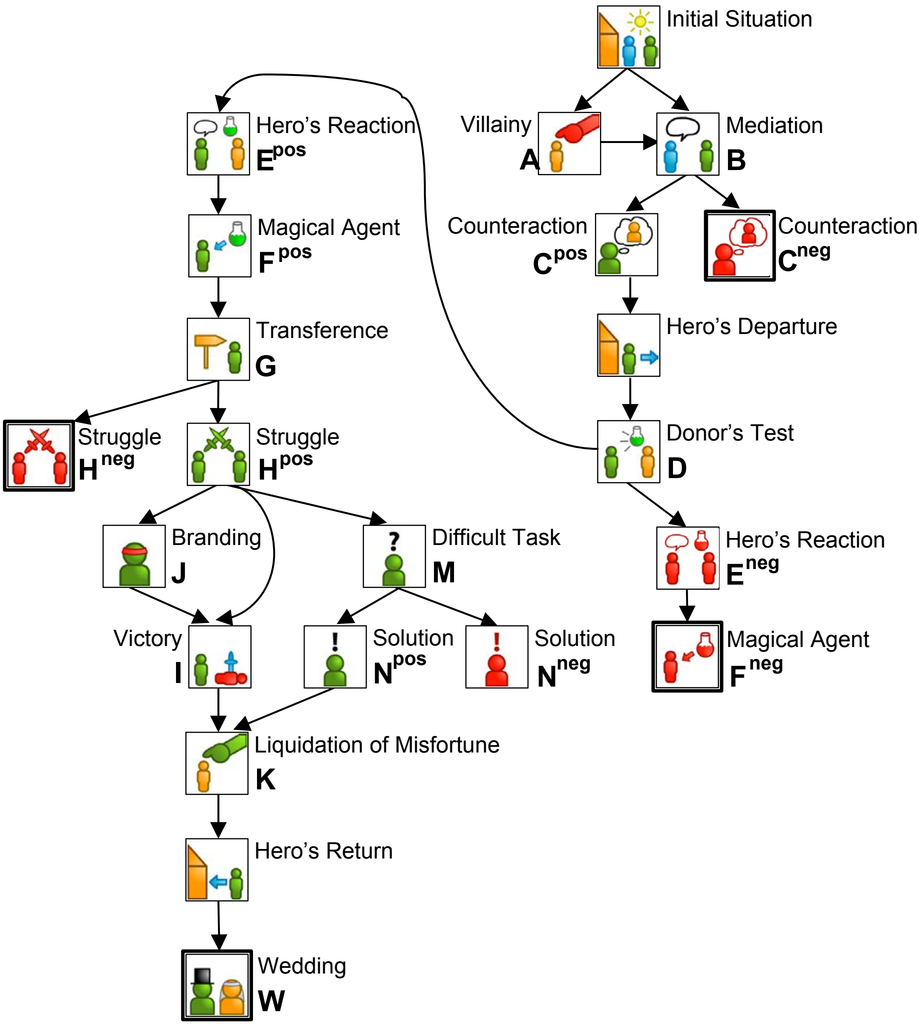

Fig. 2. A plot graph for a simple adventure game using Propp's motifs

Authors can replace Propp's motifs with another inventory of motifs (e.g., Polti's dramatic situations) or model typical patterns of social behavior, but have then to provide appropriate icons and descriptions for individual motifs and start the determination of a new classification model.

3.2 Content Editor

Scenes provide an abstract descriptions of individual plot elements. Authors can provide a textual description of the content, specify the dramatis personae and the scene location. Moreover, authors can assign behavior patterns for dialogs and interactions within a motif as well as preconditions for their successful application. This outline has to be refined by appropriate dialog sequences and interactions. Fig. 3 presents the scene editor for a plot fragment of our story.

Scenes have to be associated with motifs in order to connect the the elements of the surface and the deep structure. The proper classification of scene according to a predefined inventory of motifs is neither easy nor unambiguous as motifs can be realized in an infinite number of ways (due to abstractions, variants, and assimilations).

In order to ease this subjective and time-consuming classification, authors can exploit the classification model to select an appropriate motif. Therefore, the classifier assigns probabilities according to similarity measures between the scene and known motif descriptions. Tab. 1 lists the suggested motif classifications according to the scene description in Fig. 3.

Fig. 3. Content editor view

This semi-automatic classification supports a consistent classification of scenes and a dynamic inventory of motifs within a collaborative plot authoring tool. Moreover, the consistency of the classifications within the corpus can be evaluated.

Table 1. Suggested motival classification for a scene description

Motif	Denotation
Initial situation	α
Villainy	A
Liquidation of misfortune or lack	K
Difficult task	M
Solution (negative)	N_{neg}
Solution (positive)	N_{pos}
Reaction of the hero (negative)	E_{neg}
Reaction of the hero (positive)	E_{pos}

3.3 Motif Classification

The motif definition also comprises textual descriptions of motifs and their variants. Motif descriptions, motif variants, and plot fragments taken from an annotated corpus are considered as *instances* of a common *class*. These text fragments form a *training set* to extract parameters for a *classifier* which assigns a classification to new input data.

We employed standard techniques from *document classification* [8] in our motif classification algorithm. Textual descriptions are transformed into *document vectors*.

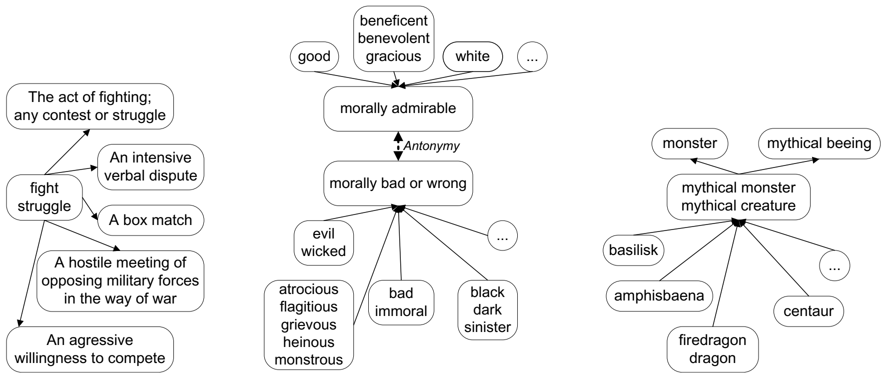

Fig. 4. Semantic fields for some actions, attributes, and dramatis personae

Therefore, the input string is segmented into tokens. Stop words are removed and morphological and inflectional variants are normalized according to Porter's stemming algorithm [14]. If the stop word list contains all determiners and preposition and inflection suffixes are removed from the remaining tokens the document vectors for the string

"The hero struggles with the evil dragon."

would contain the following set of tokens:

$$\{ \text{hero, struggle, evil, dragon} \}$$

Moreover, we employ the WordNet thesaurus to cope with semantically related lexems. WordNet [5] and its language specific variant GermaNet [6] subsume lexems that could be replaced mutually in some contexts within *synonym sets* (synsets). In other words, there is a common semantic interpretation for the lexems in a synset. Different semantic interpretations of a lexem are reflected by its contribution to different synsets. For example, the lexems *evil* and *wicked* are all member of a synset which refers to the concept of *morally bad or wrong*. This information is reflected within the middle graph of Fig. 4, which also contains other synonym sets in its nodes.

Table 2. Parts of speech, their semantic categories and lexico-semantic relations

Part of Speech	**Category**	**Relations**
Verbs	Actions, Events	Hypernymy Troponomy
Nouns	Objects	Hypernymy Meronymy Holonymy
Adjectives	Attributes	Hypernymy Antonymy

Moreover, a number of lexico-semantic relations between synsets are specified. As the individual parts of speech are associated with different semantic categories, they also obey a different inventory of lexico-semantic relations. Tab. 2 presents the parts of speech as well as their associated semantic categories and lexico-semantic relations. *Hypernymy* and *hyponymy* are the most frequent relations. They express super- and subordinations between concepts. For objects, several part-whole relations are represented: *meronymy* and *holonymy* (i.e., has-parts, is-part-of, is-member-of relation). Adjectives can express opposite attribute values (*antonymy*). Finally, *troponymy* indicate particular ways to execute actions.

Fig. 4 presents a small fragment of the graph to represent the *fighting* action (verb), the *evil* attribute (adjective) and the noun *dragon*, a typical actor for the villain role, within WordNet. The nodes contain the lexems of a synset whereas unlabeled edges represent hypernymic relations.

During a *generalization step*, the superordinate concepts for all tokens are added to the document vector. Note that this has to be done for all semantic readings as neither a part of speech tagging nor a semantic disambiguation is available in the current system. Thus, the shared superordinate concepts of semantically related lexems guarantee a minimal similarity between the document vectors for synonymic linguistic expressions.

For example, the document vectors for two plot elements of the motif *struggle* H:

The hero struggles with the evil dragon.
The hero fights with the sinister basilisk.

share the concepts *"hero"*, *"the act of fighting; any contest or struggle"*, *"morally wrong or bad"*, *"mythical monster"*, and *"mythical creature"*.

All required resources (tokenizer, stemmer, and thesauri) are available for several languages (English, German, etc.). However, we had to adopt several components to consider specific variances in the data structures between the English and German thesaurus. Moreover, the stemming algorithm also has to be applied to the entries in the thesaurus to cope with morphological variants.

We employ several classification algorithms (nearest neighbor, support vector machines) provided by the Weka data mining toolkit [21]. As the preprocessing (creation of a document vector, determination of parameters of individual classification methods) is expensive, these results are stored within a classification model of motifs. Finally, the same transformation procedure is applied for text strings before they are classified.

3.4 Story Engine: Interpretation of Player Interactions

The motival classification algorithm are also exploited in the story engine: (i) to control the narrative flow and (ii) to select an appropriate behavioral pattern for the given stimulus of the player.

The main task of the *narrative control* is to decide whether the stimuli fit best into the current motif or whether it is an indication for a context switch to a subsequent motif. Therefore, the probabilities to classify textual inputs according to the known motifs are determined automatically, whereas for other stimuli a predefined textual description is classified. To restrict the narrative flow, we consider only those motifs which can be reached from the current motif by causal or temporal links. Thus, the player could switch to all scenes reachable from the current scene if there is enough evidence to do so. This results in a flexible game play.

All characters are modeled as reflexive agents in our story engine, i.e., specific behavioral patterns (i.e., stimulus + reaction) are defined for the individual motifs. Moreover, reaction patterns can employ several media (text, sound, and animation) and specify their coordination. Behavioral patterns are represented in the AIML format [20]. The story engine incorporates a Java implementation [1] of the AIML parser.

The *pattern selection* evaluates the similarity between player stimuli within the behavioral patterns of the current narrative context. Exact matches between the input and the stimuli pattern are preferred and processed by the standard AIML interpreter. If no patterns can be applied, the similarity between the input and the stimulus is evaluated and the best pattern is selected.

3.5 Discussion

The flexibility of our authoring tool has also some implications. As authors can define new motif and delete them, scenes may have to be reclassified or to be deleted as their reference classes might not be available any more. If an author loads or stores a plot graph, the authoring tool checks whether all the scenes have been classified properly and whether all motifs do have associated scenes with them in order to guarantee the valid traversals for every path of the plot graph.

Dialogs and interactions are realized by behavior patterns for dramatis personae as well as for items. Contextual dependencies within dialogs have to be realized through setting and accessing global variables. Finally, a visual representation for the actions and locations has to be specified by defining sprites or animations as well as background graphics or view-points within a 3D scene. Note, that the dialogs provided could considerably improve the classification model of motifs.

The plot graph offers several options to adopt the plot traversal according to the player interaction: (i) by choosing different branches in the plot graph, (ii) by choosing alternative motif realizations (scenes), and (iii) through a flexible narrative flow according to the motival classification of player interactions. The consistency of the resulting story line has to be guaranteed by an appropriate arrangement of motifs in the plot graph as well as from well chosen constraints to the scene selections.

4 Related Work

The identification and extraction of narrative macrostructures and plot patterns within a genre achieved attention from various scientific communities: literature critics (e.g., Polti's dramatic situations [13]), anthropology (e.g., Levi-Strauss, Dundes), semiotics (e.g., Bremond), and psychoanalysis (e.g., Campbell's monomyth [2]) just to name a few. In text linguistics, these common structures are often described by formal grammars [3,16], document type definition (DTD) or XML schemata [7,17]. These formal grammars and structural descriptions are convincing and elegant, however, they require an expensive and subjective manual segmentation and classification.

Recently, formal inference mechanisms have been used to formalize Propp's motifs and their sequential order (e.g., using description logics [11]). These inference mechanisms could be exploited to control the game play [10].

Propp's concepts have been applied successfully to incorporate external requirements and player interactions into the plot structure of research prototypes for interactive dramas. The Theatrix project [9] employs the classification of actors with roles to characterize human and virtual agents along with their associated actions in an interactive play. In the Geist project [19], Propp's motifs are associated with locations (stages) so that the player could interact within an Augmented Reality (AR) environment to explore historic events through their movements and interactions. Moreover, an interactive plot editor for authors without computer science skills was developed in that project. However, the editor relies on a manual classification of plot elements according to the fixed inventory of Propp's motifs [18] as opposed to our approach which enables a flexible inventory.

5 Conclusion

In this paper we presented a visual authoring tool to create narrative macrostructures and to define the resources required to design an interactive drama collaboratively. The plot graph editor enables an author to define new motifs and their dependencies. This is a requirement to adopt the structural approach for genres with a greater inventory of motifs and a less strict order of motifs. Moreover, we presented a novel approach to classify motifs according to the example set (provided by Propp's famous structural analysis or a new inventory defined by dramatists or game designers). This (semi-)automatic classification supports the analysis of narratives as well as the implementation of a flexible game engine for interactive dramas.

References

1. N. Bush. Program D, Version 4.5, 2005. http://aitools.org/downloads/.
2. J. Campbell. *The Hero With a Thousand Faces*. Princeton University Press, 1948.
3. B. Colby. A Partial Grammar for Eskimo Folktales. *American Anthropologist*, 75:645–662, 1973.
4. A. Dundes. From Etic to Emic Units in the Structural Study of Folktales. *Journal of American Folklore*, 75:95–105, 1962.
5. C. Fellbaum, editor. *WordNet: An Electronic Lexical Database*. MIT Press, 1998.
6. C. Kunze and L. Lemnitzer. GermaNet - Representation, Visualization, Application. In *3rd Int. Conf. on Language Ressources and Evaluation (LREC 2002)*, pages 1485–1491, 2002.
7. S. Malec. Proppian Structural Analysis and XML Modeling. In *Proc. of Computers, Literature and Philology (CLiP 2001)*, 2001. http://clover.slavic.pitt.edu/˜sam/propp/theory/propp.html.
8. C. Manning and H. Schütze. *Foundations of Statistical Natural Language Processing*. MIT Press, Cambridge, 1999.
9. A. Paiva, I. Machado, and R. Prada. You Cannot use my Broom! I'm the Witch, you're the Prince: Collaboration in a Virtual Dramatic Game. In *Intelligent Tutoring Systems, 6th Int. Conf. (ITS 2002)*, 2002.

10. F. Peinado and P. Gervás. Transferring Game Mastering Laws to Interactive Digital Storytelling. In *2nd Int. Conf. on Technologies for Interactive Digital Storytelling and Entertainment*, pages 48–54, 2004.
11. F. Peinado, P. Gervás, and B. Díaz-Agudo. A Description Logic Ontology for Fairy Tale Generation. In *Forth Int. Conf. on Language Resources and Evaluation: Workshop on Language Resources for Linguistic Creativity*, pages 56–61, 2004.
12. K. Pike. *Language in Relation to a Unified Theory of the Structure of Human Behaviour*. Mouton, The Hague, 1967.
13. G. Polti. *Thirty-Six Dramatic Situations*. Kesslinger Publishing Company, 1916.
14. M. Porter. An Algorithm for Suffix Stripping. *Program*, 14(3):130–137, 1980.
15. V. Propp. *Morphology of the Folktale*. University of Texa Press, Austin, 1968.
16. D. Rumelhart. Notes on a Schema for Stories. In D. Bobrow and A. Colins, editors, *Representation and Understanding: Studies of Cognitive Science*, pages 211–236. Academic Press, New York, 1975.
17. G. Scali and G. Howard. XML Coding Of Dramatic Structure For Visualization. In *Museums and the Web 2004*, 2004. http://www.spacespa.it/studi_ricerche/pdf/XML_Coding.pdf.
18. O. Schneider, N. Braun, and G. Habinger. Storylining Suspense: An Authoring Environment for Structuring Non-Linear Interactive Narratives. *Journal of WSCG*, 11, 2003.
19. U. Spierling, D. Grasbon, N. Braun, and I. Iurgel. Setting the Scene: Playing Digital Director in Interactive Storytelling and Creation. *Computers and Graphics*, 26(1):31–44, Feb. 2002.
20. R. Wallace. *The Elements of AIML Style*. ALICE A.I. Foundation, 2003.
21. I. Witten and E. Frank. *Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations*. Morgan Kaufmann, 1999.