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Evaluation of Automatic Generation of Basic Stories

Federico PEINADO and Pablo GERVÁS
Depto. Sistemas Informáticos y Programación
Universidad Complutense de Madrid
Profesor José García Santesmases s/n, Madrid, Spain
email@federicopeinado.com, pgervas@sip.ucm.es

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Abstract This paper presents an application that automatically generates *basic stories*: short texts that only narrate the main events of the plot. The system operates with a representation in Description Logics, combining stored fabulas with the narrative knowledge implemented in a domain-specific ontology. The domain of application is the traditional folk tale, using the well-known morphology of Vladimir Propp as narratological background. In order to evaluate the results, human judges blindly compared one of the generated basic stories to two alternatives: one rendered directly from a stored fabula of the knowledge base and another randomly generated. As a conclusion, possibilities of measuring the utility of the system in terms of quality and originality of the generated artifact are discussed.

Keywords: Story Generation, Computational Creativity, Case Based Reasoning, Ontology, Intelligent Systems.

§1 Introduction

Content production is a major bottleneck in the entertainment industry. Whether in the development of websites, videogames or movies, companies employ large numbers of screen writers and content providers, sometimes devoting higher portions of their budgets to them than to the technical staff. Modelling how human beings create artistic artifacts also represents a big challenge from the point of view of the Humanities. For these reasons, building storytelling systems has been one of the big dreams of Artificial Intelligence (AI).

Actually, there are many systems that aim to create new stories automatically.*[1] All of these systems use a different methodology and usually they are

*[1] These systems are discussed in section 2.

difficult to compare or evaluate. This issue is related to the problem of Computational Creativity: how to create something new and useful at the same time. Many systems reuse a couple of main plots and only change secondary elements of the story world; sometimes that is enough and the story seems different to the reader, but from the point of view of Narratology this approach has no guarantee of success in terms of novelty of the fabula.

The aim of our project is to generate *creatively* new basic stories (short textual representation of the story *fabula*, a narratological term for the set of main events that happen in the plot) using a knowledge base that contains previously known fabulas. For this paper "creatively" means "obtaining a high degree of originality (many differences between fabulas) at the same time as maintaining narrative coherence".

In the next section we present a brief review of previous work in the field, section 3 provides some details on the knowledge representation while section 4 explains the architecture and process of our storytelling system. Finally section 5 presents a discussion of the initial experiment.

§2 Related Work

In order to build a storytelling system, some narrative theory is necessary as a basis for the project. There are many interesting theories in the field of Narratology, but some of them are difficult to formalize in order to translate them to a machine-processable representation. This work is based on "Morphology of the Folk Tale",[19] the classic book by the Russian formalist Vladimir Propp. Classifying a corpus of tales, Propp builds a general description of these tales, according to their ordered sequence of constituent parts, which he calls *character functions*. Although it is an early work, Proppian morphology is chosen because it provides a simple (and well-known in the field) formal system, something which it is unusual to find in other post-structuralist or semiotic narrative theories.

Storytelling AI projects can be grouped in two basic approaches: structuralist generation and transformationalist generation; in the first one story drafts go from atomic elements to complex structures (generally using production grammars) and in the second one the story is generated from the beginning to the end (usually using story planners or simulators of the characters' behavior). DEFACTO[23] is an example that uses logical formalisms to generate the structure of the story, while Tale-Spin[15] is famous for being the first approach to story generation based on the transformational paradigm.

Several projects use Proppian morphology in different ways to generate stories. OPIATE[9] is an interactive storytelling engine that generates new stories reusing tales analyzed in terms of Proppian functions, similar to the design ideas of more conventional story generators.[8] PftML[14] (Proppian fairy tale Markup Language) is a project that implements a DTD (Document Type Definition) to standardize a formal analytical model for tales based on Propp's one. Another example is The Proppian Fairy Tale Generator,[22] a simple random generator that uses Proppian functions to generate new tales, just stringing written pieces of text together. Other classic systems like Automatic Novel Writer,[12] Joseph[13] and even Minstrel[24] are inspired by the original work of the Russian formalist, which was originally conceived as a tool for analyzing tales, not to create them.

There are projects like Story Generation Algorithms[16] that merge the points of view of Narratology and Computer Science, developing a theoretical background for these systems. There are also technical improvements to the transformational approach, using sophisticated planning systems as in Fabulist.[20] Mexica[18] presents a different approach, using an iterative cycle of engagement and reflection that we consider as *iterative tranformationalism.*

Our approach does not use explicit grammars but it is closer to the structuralist generation. One of the most important references for this paper is Minstrel,[24] a system that can generate short stories in natural language about King Arthur and the Knights of the Round Table, combining a transformationalist approach with creative steps that use an episodic memory to insert changes in the fabula based on structure similarities with other fabulas.

§3 Fabula Representation

KIIDS[*2] (Knowledge-Intensive Interactive Digital Storytelling) is the background project for this paper, a system that deals with the problems of story representation and generation in many contexts, especially in interactive environments.

KIIDSOnto is the ontology of the system, created specifically for this project because there were no freely available resources that deal with joint knowledge about three basic domains: interactive goal-directed experiences, narrations and simple simulations.

KIIDS has been implemented in Java using Jena,[11] the Semantic Web Framework, and Pellet[17] as OWL Reasoner. This particular choice has some influence on the knowledge representation required for the system to operate. Actually, KIIDSOnto is built as an OWL DL ontology to take advantage of the ability of DLs (Description Logics) to allow fast reasoning in the generation of creative artifacts.[7] Basically, KIIDS uses a *case base* with stories that are composed by interrelated instances of KIIDSOnto concepts. More details about the generation process are presented in section 4 below.

3.1 The Ontology

KIIDSOnto is composed by many specific subontologies, containing knowledge of different domains. An overview of the main concepts and properties defined in the ontology is presented in Table 1.

KIIDSOnto incorporates a sub-ontology of reusable knowledge for CBR processing which is used by the system to guide the CBR cycle. This subontology follows some ideas presented in previous ontologies, such as CBROnto.[6] Additionally, KIIDSOnto also incorporates specific knowledge about basic narratology[*3] For managing folk tales, the ontology imports the Proppian morphology, another domain-specific subontology that extends the narrative concept Event

[*2] http://federicopeinado.com/projects/kiids/

[*3] According to the comments and suggestions made by recognized experts in the field.[16]

Table 1 Concepts, Datatype and Object Properties in KIIDSOnto

Concepts	
Case	subconcept of CBRThing
CaseDescription	subconcept of CBRThing
CaseSolution	subconcept of CBRThing
INSExperience	subconcept of Case
ISExperience	subconcept of INSExperience
NSExperience	subconcept of INSExperience
SExperience	subconcept of INSExperience
ProppianPlot	subconcept of NSExperience
ProppianMove	subconcept of NSExperience
ProppianResolution	subconcept of NSExperience
Datatype properties	
caseTitle	subproperty of CBRDatatypeProperty
Object properties	
caseStructure	subproperty of CBRObjectProperty
hasCaseDescripton	subproperty of caseStructure
hasCaseSolution	subproperty of caseStructure
subcase	subproperty of caseStructure
subcaseInverse	subproperty of caseStructure
dependency	subproperty of CBRObjectProperty
dependencyInverse	subproperty of CBRObjectProperty

with character functions and the narrative concept Existent with character roles. Examples of KIIDSOnto concepts belonging to these different sources are shown in Table 1.

As a CBR process, the main unit of knowledge in KIIDS is the *case*, and everything else can be found following Object property links from it.

Case. The subconcept of case that KIIDS uses in this kind of application is *NSExperience* (Narrative and Simulation Experience in KIIDSOnto terminology). It also uses instances of ProppianPlot that are composed by subcases, instances of ProppianMove; at the same time a ProppianMove is composed by an ordered set of events, that are the basic links of the plot chain.

KIIDSOnto includes a case base with 49 fabulas of Russian folk tales taken from the Afanasiev corpus originally used by Propp.

While CBR concepts and properties are used following the typical life cycle of a CBR system, narrative concepts and properties are used by KIIDS as a semantic network of constraints to generate stories according to the Narratological theory provided (in this case, Proppian morphology). The most important concepts of the narrative domain are:

Event. A narrative event is a formalization of a high level structure of the fabula. The events that are found in KIIDSOnto are 31 character functions (214 if the whole hierarchy of subfunctions is taken into account). The hierarchy of some of these functions is shown in Table 2. Every event has *cause* and *effect* properties, two connections with the previous and next events of the same tale (except for the initial and final Proppian functions that have no previous

Table 2 Proppian Functions as Narrative Events in KIIDSOnto

Concepts	
ProppianFunction	subconcept of Event
ProppianMoveFunction	subconcept of ProppianFunction
ProppianResolutionFunction	subconcept of ProppianFunction
Epilogue	subconcept of ProppianFunction
UnclearForm	subconcept of ProppianFunction
Preparation	subconcept of ProppianMoveFunction
Conflict	subconcept of ProppianMoveFunction
DonorMoveFunction	subconcept of ProppianMoveFunction
HelperMoveFunction	subconcept of ProppianMoveFunction
ConectiveIncident	subconcept of Conflict
ConsentToCounteraction	subconcept of Conflict
HeroDeparture	subconcept of Conflict
VillainyOrLack	subconcept of Conflict
Villainy	subconcept of VillainyOrLack
Lack	subconcept of VillainyOrLack
LackOfBride	subconcept of Lack
LackOfEggOfLifeDeath	subconcept of Lack
LackOfHelper	subconcept of Lack
LackOfMoney	subconcept of Lack
LackOfWondrousObject	subconcept of Lack
OtherFormsOfLack	subconcept of Lack

and next events, respectively). Included in the events is information about the characters that are involved in them.

Character. There are six character roles in the Proppian morphology: hero (the protagonist), villain (another primary character), donor, helper, prisoner and false hero (all of them secondary characters). In addition, there are tertiary characters to represent the family of the hero, the population of the Kingdom, etc. Each event is defined using some constraints over the characters that can be involved in the event in an active or passive role (e.g. a Villainy has to be executed by a villain, and the victim can be any other character except the villain himself). The characters and other *narrative existents* (according to Chatman's terminology[4]) are implemented in KIIDSOnto as the reader can see in Table 3.

The simulation domain of the ontology includes many concepts like Process, Agent, Object, Place, etc. that are useful to add detail to the tale, but in this paper only relevant aspects of KIIDSOnto are introduced with the purpose of emphasizing the fabula generation process and not confusing the reader. A similar thing happens to the interaction domain, the concepts of which are not used here because the application has no interactive component.

The ontology is used to measure the semantic distance between different fabulas, thanks to the concept hierarchy and the heuristics of the system.

KIIDSOnto and all the subontologies are implemented in OWL DL,[2] a W3C standard for the Semantic Web with a specific version for DLs[1] that is accepted directly by the majority of knowledge management tools. Protégé-

Table 3 Proppian Characters and Settings as Existents in KI-IDSOnto

Concepts	
Character	subconcept of Existent
Setting	subconcept of Existent
PrimaryCharacter	subconcept of Character
SecondaryCharacter	subconcept of Character
TertiaryCharacter	subconcept of Character
ProppianMagicalAgent	subconcept of Setting
ProppianSymbolicObject	subconcept of Setting
Protagonist	subconcept of PrimaryCharacter
ProppianVillain	subconcept of PrimaryCharacter
ProppianHero	subconcept of Protagonist
ProppianPrisoner	subconcept of SecondaryCharacter
ProppianDonor	subconcept of SecondaryCharacter
ProppianHelper	subconcept of SecondaryCharacter
ProppianFalseHero	subconcept of SecondaryCharacter
ProppianHeroFamily	subconcept of TertiaryCharacter
ProppianPeople	subconcept of TertiaryCharacter

OWL 3.1.1[5)] was used for developing the ontology.

3.2 The Case Base

As an example of the type of story fabulas that are included in the case base, the outline of *The Swan Geese* tale[*4] is given below (number 113 in the Afanasiev corpus). The events of the fabula are described using the names of the Proppian functions in the ontology:

> `InitialSituation` presenting a girl (the Hero) and her brother, a little boy (the Prisoner), `Interdiction` from their parents (the Hero's family) about not going outside, `CommandViolated` by the girl and the boy, `Kidnapping` of the boy by the swan geese (the Villain's servant), `Competition` between the girl and a witch called Babayaga (the Villain), `Victory` of the girl, `ReleaseFromCaptivity` of the boy by his sister, `TestOfHero` by the swan geese searching for the girl, `SustainedOrdeal` by the girl, `Return` of the two siblings.

§4 Knowledge-intensive Case Based Storytelling

The architecture of KIIDS is based on a *creative* Knowledge-Intensive Case Based Reasoning (KI-CBR) process similar to the process used in Minstrel. CBR relies heavily on retrieving and reusing previous solutions to solve new problems, drawing on a case base of existing problem-solution pairs encoded as *cases*; but novelty is not a requirement for the solutions of a CBR system, so we use the term Creative CBR for the Software Engineering model for AI applications that combines the powerful problem-solving approach of CBR with the creativity of other heuristic techniques and algorithms.

[*4] Complete text in:
http://federicopeinado.com/projects/kiids/apps/protopropp/swan-geese.html

Basically, KIIDS generates stories step by step, adding narrative episodes and simulation elements when they are needed to continue the storytelling process. The core of the KIIDS system is the *imaginative memory* that creates the next narrative episode of a story reusing old episodes found in the case base, taking into account the current state of the narration and using explicit knowledge about narrative and world simulation.

ProtoPropp[*5] is the name of the application that implements KIIDS for generating folk tales. The process that is introduced here is a simplification of the creative CBR process that KIIDS is able to run.

KIIDS could use any external DIG-compliant DL inference engine to reason about the ontology; ProtoPropp is currently using Pellet 1.3beta2.[17)]

4.1 Fabula Retrieval

Using the ProtoPropp interface, queries are taken as a set of constraints that define a fabula. The system can generate stories adding whatever other elements. It is not possible to add negative constraints to the query.

The fabula most similar to the user query, in terms of the distance between concepts in the ontology hierarchy, is retrieved from the case base.

4.2 Fabula Adaptation

The retrieved fabula has to be transformed into a new one using creative heuristics. There are two different kinds of adaptation, using a random process or taking advantage of the ontological organization.

The random adaptation simply creates a set of moves using a set of Proppian functions per move using the ontology in a very simple way, calculating the average number of these elements that there are in the tales of the case base. Then, active and passive characters are also assigned randomly.

The ontological adaptation is more interesting because it uses the dependency properties between Proppian functions and characters in the ontology. The most similar case is changed according to this process: some functions (that are not part of the query) are deleted randomly, including those which depend on the deleted ones. After that, other functions are added randomly too, including (again) those which depend on the added ones. Finally the active and passive character properties of the new functions are filled by a random process but using backtracking when constraints of the ontology related to the participation of characters in Proppian functions are violated.

When operating in this fashion, the system carries out an exploration of the universe of fabulas, searching for new valid combinations of existing material. In Boden's terminology,[3)] this corresponds to a process of exploratory creativity (*e-creativity*).

§5 Experiments

An experiment has been carried out to evaluate the basic stories generated by ProtoPropp. Usually to run the system it requires some input from the user,

[*5] http://federicopeinado.com/projects/kiids/apps/protopropp/

```
Once upon a time there was the girl and the little boy. The father
said to the girl not to go outside. The girl went outside. The swan-
geese kidnapped the little boy. The girl departured. The girl and
the witch started a duel. The girl won the duel. The girl rescued
the little boy. The swan-geese tested the girl. The girl passed the
test. The girl returned home with the little boy.
```

Fig. 1 Basic Story from a Corpus Fabula

```
Once upon a time the swan-geese fell in the trap of the king. The
frog used a magic spell against the witch. The king scared somebody.
Others and the knight heard about the witch. The swan-geese used a
magic spell against the lioness. The king heard something. The swan-
geese heard about the king. The little boy shared information with
somebody. The little boy said to go outside. Not went outside. The
lioness departured with the frog. The king fell in the trap. The
lioness enchanted somebody. The lioness went outside.
```

Fig. 2 Basic Story from a Randomly Generated Fabula

```
Once upon a time there was a princess. The princess said not to go
outside. The princess went outside. The princess heard about the
lioness. The lioness scared the princess. The lioness kidnapped
the princess. The knight departured. The knight and the lioness
fought. The knight won the fight. The knight solved the problem of
the princess. The knight returned. A big treasure to the knight.
```

Fig. 3 Basic Story from a Fabula Generated by the Ontological Algorithm

like a query taken from a form; but in this experiment the fabula is created from an *empty query*, running the ordinary process of the system that has been explained in section 4.

For the evaluation there is no automatic comparison between basic stories. The method used to compare basic stories was to send questionnaires by email to 48 human judges chosen from a group of students and some lecturers of the Universidad Complutense de Madrid (non-native English readers).

Three basic stories were evaluated in a blind process, all of them with the same Natural Language surface and similar structure (Fig. 1, 2 and 3); the first fabula was taken directly from the corpus of analyzed tales of KIIDSOnto (*The Swan Geese*, 113 Afanasiev), the second one was randomly generated and the last one was created by the ProtoPropp ontological algorithm (CBR and DL reasoning). For each tale, judges were asked to select numbers between 0 and 10 that described the degree to which that tale satisfied the property under consideration: *linguistic quality* (how well is the text written), *coherence* (how well is the sequence of events linked), *interest* (how interesting is the topic of the story for the reader) and *originality* (how different is the story from others). The results are summarized in Table 4.

Table 4 Evaluation of Four Properties in Three Basic Stories

Linguistic quality	*Corpus*	*Random*	*Ontology*
Mean	4.81	4.00	5.25
Standard deviation	2.09	2.37	1.99
Coherence	*Corpus*	*Random*	*Ontology*
Mean	4.88	1.81	6.94
Standard deviation	2.24	1.82	2.24
Interest	*Corpus*	*Random*	*Ontology*
Mean	4.29	3.23	5.08
Standard deviation	2.17	2.32	1.83
Originality	*Corpus*	*Random*	*Ontology*
Mean	5.04	5.44	3.92
Standard deviation	2.28	2.50	1.88

§6 Discussion

The fabula retrieved from the corpus is our reference point in the evaluation: the generated basic story is considered by the judges as a tale with acceptable values (between 4 and 6) in all the properties.

The judgements of narrative coherence are reasonably predictable and very encouraging because the random tale achieves only 1.81 while the others have more acceptable means. The ontological generator obtains the best results on coherence, which was one of the main goals for this project. The main reason for the ontological fabula to be more coherent than the corpus one is that ontology forces explicit links between events. A similar pattern emerges for the interest values: the ontological fabula obtains an acceptable 5.08, while the random one achieves a 3.23 interest value. It seems that interest has relations with coherence in some way: people tend to find little interest in incoherent stories. The evaluation of originality presents some issues that emerge in this experiment. The random fabula is expected to be more original because it is clearly different from other common sense stories, but the fact is that originality of the story selected from the corpus reaches values close to it, which is disappointing. The ontological generator fails on this property, probably because judges are evaluating the aggregation of individual elements of the fabula (stereotypical characters and functions) instead of evaluating the basic story as a whole. One explanation for these results is that notion of originality is *relative* to the knowledge of each judge. This is indicated by the spread of results shown in a 2.50 standard deviation.

The fourth property, linguistic quality, reflects the complexity of the evaluation of natural language artifacts. ANOVA test reveals that the variation of linguistic quality between the three basic stories is significant at a significance level of 5%. This result is a bit disappointing because the same template-based output method is used in the three generators. This probably means that the reader could be influenced by the text instead of the real object of evaluation: the fabula itself.

In terms of Boden,[3] the creativity values that judges assigned to basic stories are taken from an *h-creativity* (historical creativity) point of view because the judges have no idea about the history of the system and the content of its case base, so they try to compare the generated basic story with all the stories they have read, heard or seen during their lives. We found that kind of evaluation acceptable but it is true that each judge has different levels of experience and, of course, none of them truly knows *all the stories* in the history of Humanity. However, searching for *p-creativity* (personal creativity) means finding a new fabula as different as possible from the fabulas included in the case base of the system (which in this case plays the role of the creative "person"). This would require all the judges to read the complete case base of the system before evaluating.

After the experiment, for instance, we explained to the judges that the result of the ontological generation in the experiment is actually very similar to the 131st of Afanasiev collection, which is included in the KIIDSOnto case base. That means the originality value of this basic story in terms of p-creativity *should* be low, but paradoxically during the experiment some judges did not recognize the classic fabula and assigned it an acceptable h-creativity value.

The evaluation of complex artifacts such as basic stories faces important problems arising from the subjective nature of the way in which people arrive at an evaluation for them. This imposes the need for having human evaluators as opposed to qualitative measurement of the artifacts themselves. Additionally, it complicates the processing of the evaluations obtained. For this experiment we have chosen an extremely simple natural language representation of stories; the purpose of this was to avoid the *noise effect* of linguistic quality in the evaluation of judges.

Existing theoretical work on the evaluation of creative systems[21] suggests two basic magnitudes to be considered: *typicality* and *value*. Talking in terms of human evaluation instead of machine evaluation, with respect to the parameters evaluated for the experiment, a possible mapping might be to interpret the measurement for originality as related to the typicality of the examples and the measurement for narrative coherence as related to their value; the first mapping seems reasonable because it was explicitly recommended to the judges that "When evaluating kindly take into account that the computer program's goal is to create simple traditional folk tales." so they can compare the results to all the stories of that kind they have read, but the second mapping is more problematic because the four properties interact in some way and probably is not possible to measure the value of a story considering each property really independent from the others.

There are other important factors involved in the intuitive way a reader sizes up a story on first approaching it. A valuable proposition in terms of measuring these factors is provided by Pérez y Pérez.[18] The Mexica storytelling system considers the tension of the stories that it generates, measured in terms of how the characters in the story suffer changes in their emotional reactions to other characters and their perception of threats to their life or health. A story is considered valuable relative to how often tension rises and falls throughout its duration.

Although this representation of tension is crude, it provides a very good initial approximation to an issue that certainly needs to be addressed by storytelling systems. It is expected that the ontology and the DL reasoning capabilities of the next version of KIIDS play an important role in adequately modelling complex issues such as tension and other related properties that may need to be taken into account.

§7 Conclusion

Our design allows the application to change the content of each story at the same time as it clearly maintains the coherence of the narrative structure. The originality of the product is not guaranteed (neither the interest of the story) but we are optimistic about finding good results without complex heuristics.

KIIDS uses an ontology for representation of its underlying knowledge. This constitutes a natural evolution from the frame systems used in previous work, such as in Minstrel.

KIIDSOnto is an extensible ontology that allows the designer to add new concepts about narrative or simulations. As long as those new concepts use KIIDS-compatible properties and get connected with the general concepts of the ontology, the coherence of the process is guaranteed. Next steps are going that way, towards the formalization of modern Narratology far beyond Proppian morphology, taking advantage of the conceptual reusability of KIIDSOnto.

This experiment shows how random alternatives can become dangerous enemies for the developers of creative systems: if the results of the evaluation do not show *significant advantage* for the creative system against a simple random algorithm, the research effort can claim little merit; and the question is not just about building a better algorithm, but also about showing (probably with qualitative measures) why the created algorithm is better.

More experiments are needed to measure the originality in terms of p-creativity, comparing each generated fabula with the whole corpus that is used in its generation. There is also more work needed in improving the adaptation algorithm and enriching the representation of the fictional world for each tale. Even if it is currently at an acceptable level, the next development steps also include addressing a more elaborated natural language generation module that will transform the plot plan into a better textual rendition, akin to that described by Gervás.[10]

To sum up, using this architecture storytelling systems can reuse previously known fabulas and obtain a coherent and reasonably original basic story.

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Federico Peinado: He is a Teaching Assistant at Universidad Complutense de Madrid, Spain. He received his B.S. and M.Phil. in Computer Engineering from the UCM in 2002 & 2004. His research is focused on Computational Narratology, Game Design and the applications of Artificial Intelligence and Computational Creativity to humanistic domains.

Pablo Gervás, Ph.D.: He is Associate Professor at Universidad Complutense de Madrid, Spain. He received his B.S. from the Universidad Complutense de Madrid in 1990 and his Ph.D. from Imperial College London in 1995. He has contributed research results in information retrieval, natural language generation, case-based reasoning and computational creativity.