Creativity Issues in Plot Generation

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Abstract

This paper presents an application that automatically generates plots for tales, using the narrative morphology of Vladimir Propp. The system operates with a representation in Description Logics, combining stored plots with the narrative knowledge implemented in a domain-specific ontology. The results are compared with the plots created by a random generator and the authors discuss about how to measure the results.

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. The fact is that, for several reasons, building storytelling systems has been one of the big dreams along the history of Artificial Intelligence (AI) research.

Actually, there are many systems that aim to create new stories on the fly. Each one use a different approach and nowadays it is difficult to compare one methodology to another. This issue is related to the problem of Computational Creativity, to create something new and useful at the same time. The majority of storytelling projects reuse a couple of main plots and only change elements of the story world, like characters, objects, places, etc. 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 creativity.

The aim of our project is not to create a stand-alone story and then make it up with slight changes each time the reader asks for a new one. Actually, our assignment in this step of our project is to generate stories structures (narrative skeletons) that result *truly creative*, which means "maintaining narrative coherence and a relative high degree of novelty (differences between them)".

As narrative support we use the classic work of Vladimir Propp. Nowadays this is not the most useful model for narratologists because it lacks many good properties, but it is simple and understandable enough for us to create plot cases that are composed only by an ordered sequence of narrative functions.

In section 2 there is a brief review of previous work in the field, section 3 gives some details about the knowledge representation, section 4 explains the architecture and process of our storytelling system and finally section 5 presents a discussion of the initial experiment.

2 Previous Work on Plot Generation

To build a storytelling system it is necessary to have some narrative theory as a basis for the project. There are many theories in the field of Narratology, some of them not very useful for a computer scientist. This work is based on "Morphology of the Folk Tale" [Propp, 1968], the classic book by the Russian formalist Vladimir Propp. Classifying a corpus of tales, Propp builds a general description for these tales, according to their constituent parts, which he calls narrative *functions*. This author is chosen because Proppian morphology has a well-known formal system for the experts in the field that is easier to translate into a machine-processable representation than other narrative theories.

In AI there are also many storytelling projects too, they can be grouped in two basic approaches: structuralist generation and transformational generation. The first one is generally associated with production grammars and the second one normally uses a simulation of the characters behavior. Our approach does not use explicit grammars but it is closer to the structuralist generation. One of the most important references for this paper, that uses a sort of combination of both approaches, is the work of Scott R. Turner in Minstrel [Turner, 1992], a system that can generate short stories in natural language about King Arthur and the Knights of the Round Table. Mexica [Pérez y Pérez and Sharples, 2001] presents other interesting approach, using a iterative cycle of engagement and reflection.

There are projects like Story Generation Algorithms [Meister *et al.*, 2005] that merge the points of view of Narratology and Computer Science, developing a theoretical background for these systems; in the literature other relevant projects can be found that use the same tools in similar domains, like COLIBRI's poetry generator [Díaz-Agudo *et al.*, 2002].

Finally, several projects use Proppian morphology in different ways to generate stories. OPIATE [Fairclough and

Cunningham, 2003] is an interactive storytelling engine that generates new stories reusing plots analyzed under the terms of Proppian functions, similar to the design ideas for ProtoPropp [Díaz-Agudo *et al.*, 2004]. PftML (Proppian fairy tale Markup Language [Malec, 2005]) is a project that implements a DTD (Document Type Definition) to standardize a formal analytical model for tales based on Propps one. Another example is The Proppian Fairy Tale Generator [Seifert *et al.*, 2005], a simple random generator that uses Proppian functions to create fairy tales, in this case just stringing written pieces of text together. Other classic systems like Joseph [Lang, 1997], Rumelharts [Rumelhart, 1975] or Minstrel [Turner, 1992] are inspired as well in the illuminating work of the Russian formalist, that was originally conceived to analyze tales not to create them.

3 Knowledge Representation for Plot Generation

The KIIDS (Knowledge-Intensive Interactive Digital Storytelling) system is the background project of this paper, a software tool that deals with the problems of story representation and story generation in many contexts, specially in interactive environments. Details about the storytelling process are presented in section 4.

KIIDS can reason about concepts of three basic domains: interactive goal-directed experiences, narrations and simple simulations. These three domains are combined in a main source of knowledge, using the same knowledge representation, that is called KIIDSOnto. KIIDSOnto is built as a Description Logics (DLs) ontology to take advantage of the ability of DLs to allow fast reasoning in the generation of creative artifacts [Díaz-Agudo *et al.*, 2002]. This ontology has been created specifically for this project because there were no freely available resources that deal with this specific problem. KIIDS additionally uses a *case base* with many stories that are composed by interrelated instances of KIIDSOnto concepts.

The KIIDS system is implemented using a Java framework for Case-Based Reasoning (CBR) applications, jCOLIBRI[1] (Cases and Ontology Libraries Integration for Building Reasoning Infrastructures implemented in Java) [Bello-Tomás *et al.*, 2004]. This particular choice has some influence on the knowledge representation required for the system to operate, as is discussed in this section.

3.1 The Ontology

KIIDSOnto is an ontology composed by other specific subontologies, related to different domains. An overview of the main relations and properties of KIIDSOnto is presented in Figure 1.

This implementation of KIIDS uses information about the Proppian morphology, which narrative functions are implemented in one of those subontologies below the narrative Event node. KIIDSOnto also includes an OWL DL version of CBROnto [Díaz-Agudo and González Calero, 2003], an ontology that incorporates reusable CBR knowledge for the

[1] http://gaia.sip.ucm.es/grupo/projects/jcolibri/

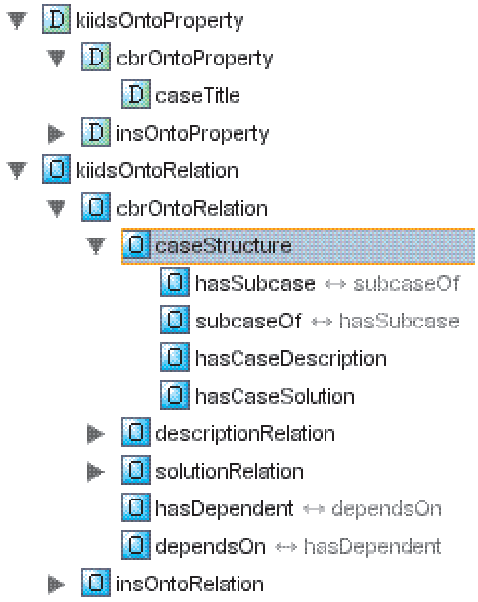

Figure 1: Relations and properties in KIIDSOnto

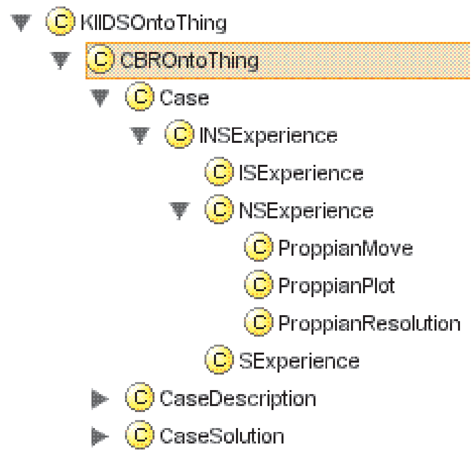

Figure 2: Concepts of CBROnto subontology

jCOLIBRI's CBR process and it is used in every extension of the framework, including KIIDS. The main concepts of CBROnto are shown in Figure 2.

The *case* concept is the most important in every CBR process. Every case has two components: description and solution. The first is useful to find the suitable case for a given problem and the second component is the piece of knowledge that the system has to adapt in order to obtain the real solution to the given problem. The biggest and most complex unit of knowledge in KIIDSOnto is also the case, and everything else can be found following relations from a case instance.

Case. The case that KIIDS uses in this storytelling application are *NSExperiences* (Narrative and Simulation experiences in KIIDSOnto terminology), pieces of knowledge that include information about narrative and simulation. Some of those plot cases are composed by subcases, called *moves*, that are the basic links of the plot chain in terms of Proppian morphology. Each move is composed by an ordered set of events.

KIIDSOnto includes a case base with the plot structures for 49 Russian fairy tales taken from the Afanasiev corpus originally used by Propp.

The other domain which role is important to understand in this paper is the narrative domain. The formalism for representing these concepts is the same we are using for CBR, but the use is completely different. While CBR concepts are used by jCOLIBRI following the typical life cycle of a CBR system (basically retrieval and adaptation of cases), narrative concepts and relations are used by KIIDS as a semantic network of constraints to generate coherent stories according to the Narratological theory that is implemented in KIIDS (in case of this paper: 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 plot. The events that are found in KIIDSOnto are 31 Proppian functions that are explained in the Propp's book (214 if the whole hierarchy of subfunctions is taken into account). The hierarchy of some of these functions is shown in Figure 3. Every event has *cause* and *effect* relations, two connections with the previous and next events of the same tale (except for the initial and final Proppian functions that has no previous and next events, respectively). The events also includes information about the characters that are involved in them, *actively* or *passively*.

Character. There are six types of characters in the Proppian morphology: hero (the protagonist), villain (another primary character), donor, helper, prisoner and false hero (all of them secondary characters). Finally there are other secondary characters to represent the family of the hero, the population of the Kingdom, etc. but they have little relevance in the story. 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 itself). The characters and other *narrative existents* (according to Chatman [Chatman, 1986] terminology) are implemented in KIIDSOnto as the reader can see in Figure 4.

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 purposes of emphasize the *abstract* plot generation process and not confusing the reader. The same is valid for the interaction domain, which concepts are not used by ProtoPropp because it is not an interactive application.

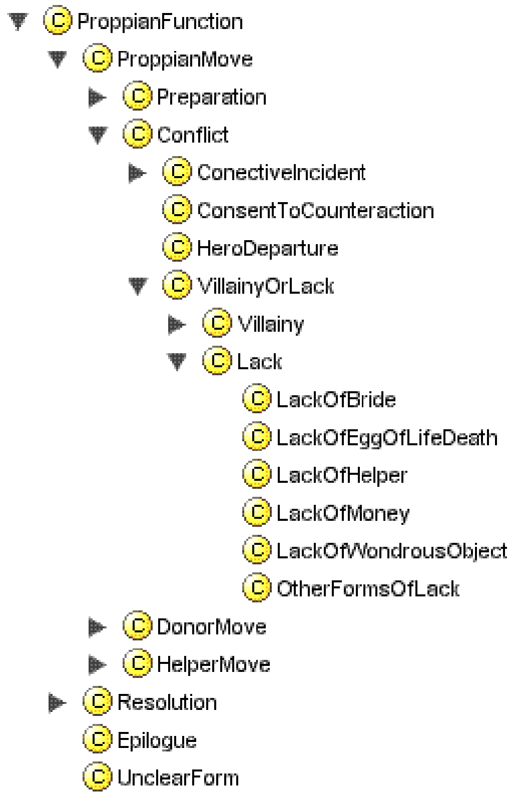

Figure 3: Proppian functions in KIIDSOnto

The ontology is used for the creative algorithms to measure the semantical distance between different plots, thanks to the concept hierarchy and the heuristics of the system.

KIIDSOnto and all the subontologies are implemented in OWL DL [Bechhofer *et al.*, 2005], an XML knowledge representation standard for the Semantic Web with a specific version for DLs [Baader *et al.*, 2003]. This choice provides the advantage that this language is an W3D standard that is accepted as a direct input in the majority of knowledge management tools.

The application that it is used to manage the ontology is the Protégé 3.0 ontology editor[2] developed at Stanford University [Gennari *et al.*, 2002].

3.2 The Case Base

As an example of the type of story plots that are included in the case base, the following outline of *The Swan Geese* tale[3] is given below (number 113 in the Afanasiev corpus) . The main events of the plot are described using the names of the Proppian functions in the ontology:

[2]http://protege.stanford.edu/

[3]Complete text in: http://gaia.sip.ucm.es/grupo/projects/ProtoPropp/swan-geese.html

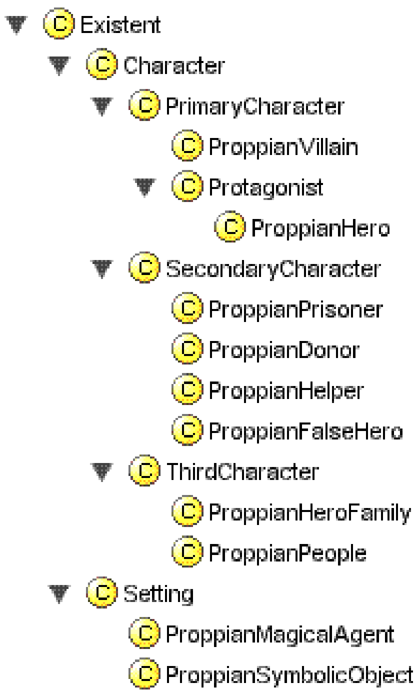

Figure 4: Characters and settings in KIIDSOnto

> `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 [Turner, 1992]. 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*. Creative CBR is a Software Engineering model for AI applications that combines the powerful problem-solving approach of CBR with the creative features of other techniques and algorithms.

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 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 is the name of the application that implements KIIDS system for a specific purpose: generate new plots for fairy tales. The process that is introduced here is a simplification of the creative CBR process that KIIDS is able to run.

ProtoPropp uses a external DLs inference engine called Racer [Haarslev and Möller, 2003] to reason with the ontology knowledge.

4.1 Plot Case Retrieval

There are two different graphic interfaces for the user. The first one is the Audience interface and the second one is the Author interface. In the Audience interface there are combo boxes to introduce the query in terms of entities and processes of the story (people, objects, verbs...). The Author interface extends that functionally adding combo boxes for advanced options, like the characters, settings and Proppian functions involved in the tale.

The query is taken as a set of constrains that define a plot case. The system can generate stories adding whatever other elements because it is not possible to add negative constrains in the query. The more similar plot to the user query, in terms of the ontology hierarchy, is retrieved from the case base.

4.2 Plot Case Adaptation

The retrieved plot 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 relations.

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

The ontological adaptation is more interesting because it uses the dependency relations between Proppian functions and characters in the ontology. The more similar case is changed according to this process: some functions (that are not part of the query) are deleted randomly, including those which depends 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 characters relations of the new functions are filled by a random process but using backtracking when constrains of the ontology related to the participation of characters in Proppian functions are violated.

The creativity involve in this process is called exploratory creativity (*e-creativity*) in the book of Margaret A. Boden [Boden, 1990], that means the system carries out an exploration in the universe of story plots, searching for new useful combinations.

5 Experiment and Discussion

In this section we present an experiment to compare the plot cases generated by ProtoPropp with other kind of plot cases. Usually for running the system it needs some input from the user, like a query taken from a form; but in this experiment, the plot is created from scratch, actually using an *empty query* to use the ordinary process of the system that has been explained in section 4.

Initial situation
Interdiction **active:**hero's family **passive:**hero
Command violated **active:**hero
Kidnapping **active:**villain **passive:**prisoner
Departure of other youth **active:**hero
Competition **active:**hero and villain
Victory in competition **active:**hero
Release from captivity **active:**hero **passive:**prisoner
Test of hero **active:**helper **passive:**hero
Sustained ordeal **active:**hero
Return **active:**hero **passive:**prisoner

Figure 5: Retrieved plot from corpus

Initial situation
Interdiction **active:**prisoner
Command violated **active:**prisoner
Information receipt about villain **active:**hero **passive:**villain
Other villain trick **active:**villain **passive:**prisoner
Kidnapping **active:**villain **passive:**prisoner
Departure **active:**hero
Struggle **active:**hero and villain
Victory in struggle **active:**hero
Liquidation of lack **active:**hero **passive:**prisoner
Return **active:**hero
Material reward **passive:**hero

Figure 6: Generated plot by the ontological algorithm

Hero falls victim **active:**donor **passive:**villain
Magical agent application **active:**false hero **passive:**people
Other villain trick **active:**villain
Information receipt by others **active:**helper **passive:**people
Magical agent application **active:**donor **passive:**hero
Information receipt **active:**villain
Information receipt about villain **active:**donor
Interchange of information **active:**prisoner
Command **active:**prisoner
Command violated
Departure of other youth **active:**hero **passive:**false hero
Hero falls victim **active:**villain
Incantation **active:**hero
Command followed **active:**hero

Figure 7: Randomly generated plot

In this evaluation there is no automatic comparison between plot cases, we have preferred to organize an informal, preliminary exploration, sending emails with a simple test to nine human judges chosen from a group of students and lecturers of the Facultad de Informática. The evaluation was blind evaluation with nine judges

Three plot cases were evaluated in a blind process, all of them with the same surface and structure (Figures 5, 6 and 7); the first one has been taken directly from the corpus of analyzed tales of KIIDSOnto (*The Swan Geese*, 113 Afanasiev), the second one has been created by the ProtoPropp ontological algorithm (CBR process and Racer) and the last one has been randomly generated. The results are shown in Tables 1 and 2. Judges were asked to select for each tale an expression - out of a set provided by the developers - that described the degree to which that tale satisfied the property under consideration (coherence or novelty). The tables present the number of judges that selected each expression as applicable to the three examples being evaluated.

Coherence	***Corpus***	***Ontology***	***Random***
Null	0	0	4
Very low	0	1	3
Low	1	2	1
Medium	2	1	1
High	4	3	0
Very high	2	2	0
Maximum	0	0	0

Table 1: Coherence evaluation of plot cases (in votes)

Novelty	***Corpus***	***Ontology***	***Random***
Null	1	0	1
Very low	0	1	1
Low	6	2	3
Medium	2	5	2
High	0	1	1
Very high	0	0	0
Maximum	0	0	1

Table 2: Novelty evaluation of plot cases (in votes)

The results about narrative coherence are reasonably predictable, but the novelty evaluation presents some issues that clearly emerge in this experiment.

The corpus plot is our reference point in the evaluation, in the experiment it is considered by the judges as a tale with high coherence. The majority of judges give a null or a very low coherence value to the random plot but the result of ProtoPropp generation is not that bad, closer to the corpus plot than to the random one.

Six judges assign a low value for novelty to the corpus plot, while the ontologically generated case receipt a medium value in that property by five judges. Anyway, it is curious that the random generator does not receipt a clear better novelty than the ontological one; our explanation for that is as follows: notion of novelty is *relative* and in this experiment its meaning is not clear for the judges (as indicated by the spread of results shown in Table 2). The plot cases are not clear enough to identify the genre of the tales, and the judges informal comments we have receipt mention how difficult it is to measure novelty in abstract artifacts.

In terms of Boden [Boden, 1990], the creativity values that judges assigned to plot cases are taking 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 plot with all the stories they have read, hear or seen during their lives. We found that kind of evaluation is not a good idea because each judge has different narrative experiences and, of course, none of them knows *all the stories* in the world. However, searching for *p-creativity* (personal creativity) means finding a new plot structure as different as possible from the stories include in the case base, that is a more attainable task (if your case base is readable and small enough for a judge to read it completely). After the experiment, for instance, we explain to the judges the result of the ontological generation in the experiment is actually very similar to the 131st of Afanasiev collection, which is included in KIIDSOnto case base. That means the novelty value of this plot in terms of p-creativity *should* be low, but paradoxically some judges do not recognize the plot and give a medium or even high value to that plot.

The evaluation of complex artifacts such as story plots faces important problems arising form 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 unusual representation of stories, showing the abstract plot structure directly to the judges instead of a natural language representation of the tale. The purpose of such behavior was to avoid the *noise effect* of rendering the plot -the real product under evaluation- into text, to give the judges direct access to the creative results.

Existing theoretical work on the evaluation of creative systems [Ritchie, 2001] 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 novelty a 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 “For the evaluation take into account that the plot schemas will be rendered to classic fairy tales” so they can compare the results with their abstract notions of “tale”, but the second mapping is more problematic because coherence is not the only *value* for a narrative (although actually it is the main goal for ProtoPropp now).

On the other hand, under certain conditions stories with a low degree of narrative coherence may be considered valuable precisely because, in a context where most stories exhibit narrative coherence, they are novel. The borders between the two parameters involved in that choice seem vague.

There are clearly many more factors involved in the intuitive way a reader sizes up a story on first approaching it. A valuable proposition in terms of measuring other important factors is provided by Pérez y Pérez [Pérez y Pérez and Sharples, 2001]. 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. The version of KIIDS described here does not address it, but there are plans to include it in the future. It is expected that the ontology and the reasoning capabilities that its DLs implementation provides will play an important role in adequately modeling complex issues such as tension and other related properties that may need to be taken into account.

6 Conclusions

Our design allows the application to change the content of each story at the same time as it maintains the coherence of the narrative structure. The novelty of the product is not guaranteed but we are optimistic about finding good results without complex heuristics. KIIDS constitutes an evolution on Minstrel in as far as the ontology used for representation is a formal evolution of the frame system used in Minstrel [Turner, 1992].

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 relations and get connected with the general concepts of the ontology, the coherence of the process is guaranteed. Even our next steps are also going that way, formalizing 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 *clear advantage* for the creative system against a simple random algorithm, the research effort can claim little merit; and the question it 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 novelty in terms of p-creativity, comparing each generated plot with the corpus plots that are used in its generation. It will definitely mean not using abstract representation of plots but more readable text. There is also more work needed in improving the adaptation algorithm and enriching the representation of the fictional world for each tale. Next development steps also include addressing a more elaborated natural language generation module that will transform the plot plan into a textual rendition, akin to that described in [Gervás *et al.*, 2004].

To sum up, using this architecture storytelling systems can reuse old plots and obtain a coherent and reasonably creative new one.

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