Narrative Extraction, Processing and Generation for Interactive Fiction and Computer Games

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Abstract

Often, computer games require meaningful stories and complex worlds in order to successfully engage players. Developing a high-quality story and rich characters can be one of the hardest tasks in the game development process. Narrative is a key element in building game worlds for interactive digital entertainment. I am particularly interested in computational narrative algorithms that can analyze stories, model narrative, and generate plots to be used in various forms and game domains.

Introduction

Oral and written language have been for centuries the natural mediums in which stories have been communicated. There is a huge amount content available in natural language forms and natural language offers a barrier-free entry for non-technical authors to tell their stories.

I want to focus my research on the exploitation of Natural Language Processing (NLP) techniques for the extraction of computational narrative models from natural language text and the generation and rendering of such models. I am interested in studying how can computers understand stories automatically or how to use narrative input (in natural language) to guide Procedural Content Generation (PCG). For example, I look at Natural Language Generation (NLG) as a specialized form of PCG for rendering narrative and the interactions of a player in a game world as a storytelling session. In general, I want to explore alternative storytelling devices and PCG for computer games.

There are several areas of special interest that I would like to research further:

1. **Computational Narrative**: Computational narrative explores the age-old creative form of storytelling by algorithmically analyzing, understanding, and most importantly, generating stories. Work in the area of story understanding has ranged from the early work of Roger Schank (Schank and Wilensky 1977; Cox and Ram 1992), focused on the higher level constructs humans use to understand, memorize and reason about stories, to more recent work from the information retrieval community (Chambers and Jurafsky 2009), focused on extracting narrative schemas (Schank's scripts) and their participants from natural language text. Concerning story generation, many existing systems capable of plot generation and interactive storytelling (Fairclough and Cunningham 2003; Mateas and Stern 2003; Peinado and Gervás 2006). Moreover, in my work, I am interested in systems that can understand and generate narrative directly in natural language text, and many existing systems require as input a game world specification containing story scripts and or some other model of a narrative. Several models of narrative have been proposed but they rely on manual creation and heavy annotation (Mani 2012). Finlayson (2008) created the STORY WORKBENCH, a semi-automatic tool to extract narrative structures from text via annotation. Similar work has been done by Elson (2012) in SCHEHERAZADE. Goyal et al. (2010) worked on extracting actors and affect states in order to automatically create plot units. Calix et al. (2013) presented an approach to automatically identify actors directly from natural language (either audio, or text).
2. **Natural Language Generation**: Natural Language Generation (NLG) is one of the longstanding problems in Artificial Intelligence. Several game generes could benefit from NLG; from interactive fiction to dialogue agents in role playing games. Natural language text generation can be described as a multi-step process that could be generalized as a processing pipeline with the following stages (Reiter and Dale 2000): 1) *Document planning* determines the content and structure of a document; 2) *Microplanning* decides words and syntactic structures to communicate the previously defined content; 3) *Surface realization* maps internal structures into actual text embodying all decisions related to the grammar and morphology of a particular language. There has been much work done on the first two stages of the NLG pipeline, but, regarding surface realization, existing work tend to rely on annotated templates and rule-based systems. Text generation systems may use annotated templates with gaps that are filled by the system with the underlying information that needs to be conveyed. "Canned text" and template-based solutions are appropriate for some situations, and may even be psychologically realistic up to a point. However, these simple approaches have limita-

tions. The main drawback of canned text systems is the necessity of creating a large base of templates and annotate those accordingly for proper selection and replacement. The resulting systems are relatively inflexible, and all content has to be anticipated ahead of time. They also tend to work best where the output is brief (Hovy and Arens 1998).

3. **Procedural Map Generation**: Designing a spatial environment for action, adventure or role-playing computer games is a complex process. It requires the consideration of spatial requirements and narrative requirements as well as their interconnection. Existing work has been done in interactive narrative and procedural map generation separately from one anther in most cases. On the one hand, there has been extensive work towards procedurally generating different types of spatial structures, focusing mostly on terrain (Smelik et al. 2009). On the other hand, there has also been a significant amount of work on automatic story generation and interactive storytelling (Riedl and Bulitko 2013; Gervás 2009). Both bodies of work have been applied to computer games, the former in several forms, especially maps for dungeon crawlers and sandbox simulations (e.g. ROGUE, MINECRAFT) (Togelius et al. 2011); and the later through the concepts of experience and drama management (e.g. PASSAGE, LEFT 4 DEAD) (Riedl, Thue, and Bulitko 2011). Recent work has started to integrate narrative components into map generation. CHARBITAT, by (Ashmore and Nitsche 2007) generates an infinite game world and instantiates prefabs and quests to support a story and explore PCG for context on top of content. GAMEFORGE, by Hartsook et al. (2011), is a system capable of generating a map given a linear story represented by a sequence of plot points. Dormans and Bakkes (2011) explore the idea of stories and maps as parallel structures; the first holding the logical causal relationship between the sequence of events and the second one the spatial description of the playable map where the story will unfold. In both approaches, the story is used to generate a map from a story but the process described is of a sequential pipeline with independent processes.

Research Plan

I have looked into applying existing Natural Language Processing (NLP) techniques to the specific domain of storytelling in order to extract key narrative elements and be able to reuse them for PCG. By addressing these issues I expect to be able to develop new frameworks for NLP and PCG that can be used by interactive narrative authors and computer game designers to provide a better experience for their audience.

In order to address the research questions raised previously I intend to explore different research directions in the three areas described above:

1. **Computational Narrative**: I am interested in computational narrative algorithms that can analyze text, model narrative, and generate stories. Inspired by a hierarchy of such elements as proposed by S. Chatman (1980), I would like to apply Information Extraction (IE) and other NLP techniques to extract similar structures from natural language text. I would like to explore algorithms for the extractions of higher-level structures and narrative models. I believe current NLP systems can be complemented with commonsense and narrative domain knowledge in order to improve the result performance for the specific domains of storytelling and interactive fiction. My goal differs from the line of research of question answering community in that I am interested on extracting symbolic structures, rather than retrieving sentences or documents given queries. I want to study dramatic theories from the humanities and bridge the efforts of the NLP and cognitive AI fields into narratology systems for the digital entertainment domain. My long term goal is to design computational narrative systems that can both analyze, process, generate and evaluate narrative. In order to attain my goals I need to study models for story and discourse; and the characteristic elements of each of those areas described by different theories.

2. **Natural Language Generation for Interactive Narrative**: I am interested in addressing this problem via *text adaptation*. The motivation is that many interactive narrative systems use pre-authored text snippets; by allowing such systems to modify existing text, we enable the system to tailor text to specific players, or circumstances. I am planning on using Case-Based Reasoning (CBR) to develop a robust and flexible system. The framework should contain algorithms that are general in nature and do not require specific domain or language information encoded and can work using readily available NLP tools and a set of provided examples to automatically build the CBR cases. The main idea is that a given piece of text can be automatically modified by the system to convey the desired information. This method provides great advantages, the most prominent being a simplification or removal of the template generation and annotation processes, but at the same time poses additional problems.

3. **Story-Based Procedural Map Generation**: I also want to look into using narrative techniques and alternative storytelling devices for PCG. Specifically would like to explore map and game world generation. I intend to explore the correlation between stories and the spatial configuration of the environment where these stories unfold. I propose a framework which, given the specification of a *story space* can generate maps that support one or more stories from that story space. The key technical challenges that I would like to address are: 1) how to properly model and encode narrative information 2) how to automatically generate game maps from a given narrative structure, 3) how to evaluate the quality of a given map based on the different stories that it supports, and 4) how to generate a graphical realization of the map.

Progress

The following progress has been made on my proposed research:

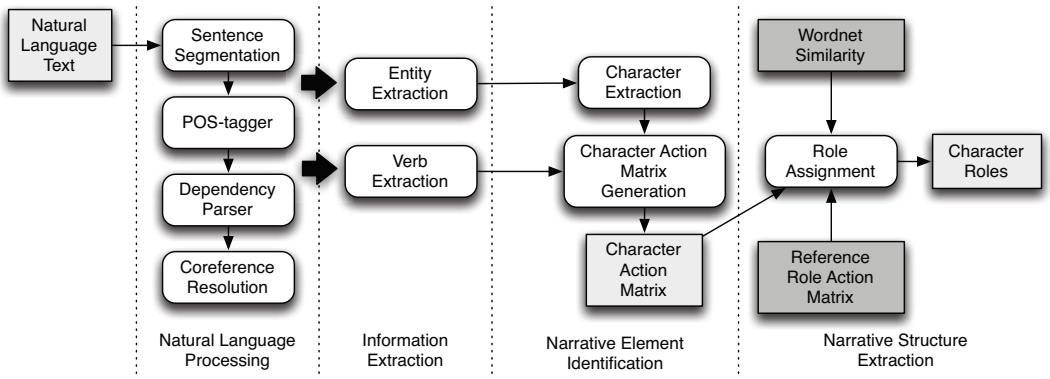

Figure 1: Overview of our current prototype for a narrative extraction which is capable of identifying actors and their roles via the exploitation of common sense knowledge and narrative domain knowledge. Submitted to the Intelligent Narrative Technologies workshop at AIIDE 2013.

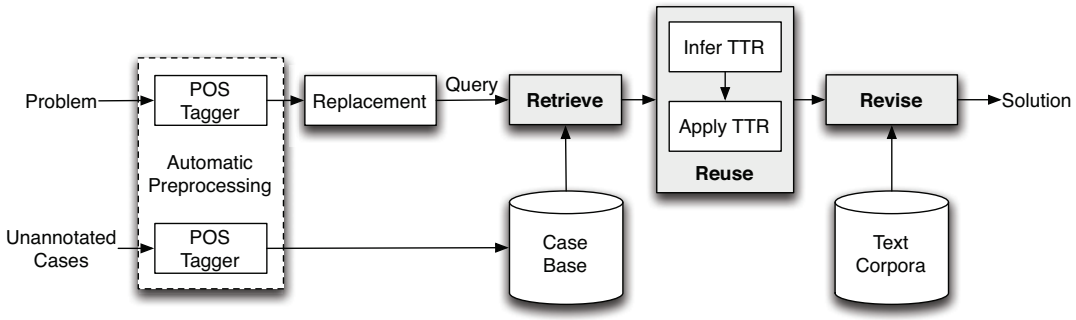

Figure 2: System architecture for CEBETA (Valls-Vargas and Ontañón 2012), a case-based approach to text modification capable of several number, gender and tense transformations on a given sentence. Work published at ICCBR 2012.

1. **Toward Automatic Extraction of Story-Structure from Natural Language Text**: We have been working on an NLP workflow for automated narratology processing. A first prototype uses extracted entities and verbs to filter characters and then combines the information with an external narrative theory to identify character roles in the story. Our current system features some extraction and augmentation capabilities and uses Propp's theory (Propp 1973). It has been submitted to the Intelligent Narrative Technologies workshop at AIIDE 2013. Figure 1 shows the workflow implemented in our first prototype. We are working towards expanding and enhancing the capabilities of the system.
2. **Natural Language Generation through Case-based Text Modification**: We presented CEBETA (Valls-Vargas and Ontañón 2012), a case-based approach to text modification capable of several number, gender and tense transformations on a given sentence. In our system, a problem is formulated as a plain text sentence and some desired replacement in order to convey some new information. Pairs of plain text sentences implementing specific transformations represent cases. NLP tools are used to automatically process the cases and infer the required text transformation routines used for text reuse. Our system applies the inferred transformation routines and evaluates the sentence using a probabilistic model in order to fix any grammatical errors. Figure 2 shows the system architecture for CEBETA. I integrated a version of CEBETA into RIU, an interactive narrative system (Ontañón and Zhu 2010). RIU uses computational analogy to find mappings between scenes and then performs replacements for the matched tokens in the textual description of the scenes. My module performed the requested replacements plus any other that would be required in order to maintain grammatical correctness and coherence.
3. **Towards Story-Based Content Generation: From Plot-Points to Maps**: We built a system that can procedurally generate game maps using story evaluation techniques. Currently our system generates tile-based maps from an input consisting of plot points encoded as planning operators. The plot points are annotated with location information. The locations are extracted and an several environment configuration graphs generated. Then, the subset of stories supported by each graph are evaluated and the best environment configuration graph is realized into a map. Figure 3 shows the output of our prototype during the story planification, the environment configura-

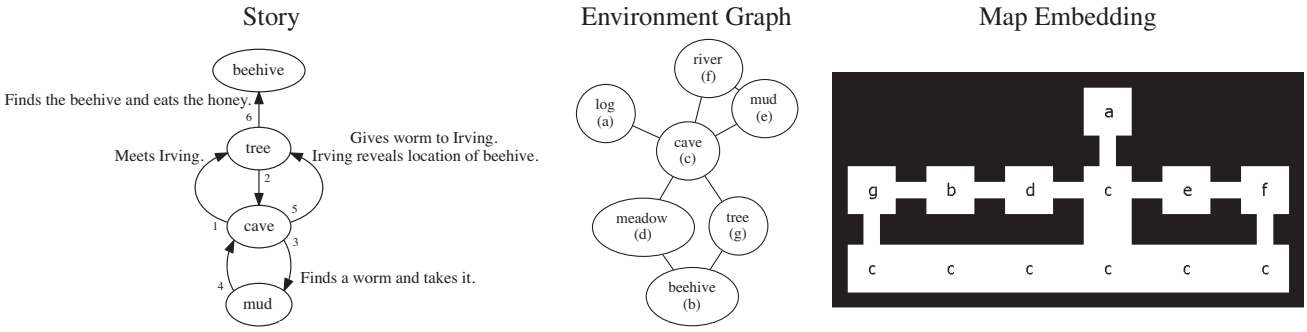

Figure 3: Three stages of our system for story-based map generation. Work accepted at CIG 2013.

tion and the final map embedding. This research has been accepted at CIG 2013.

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