1 Introduction

Stories or narratives are shared in every culture as means of entertainment, education, and preservation of culture. Storytelling is a central aspect of human life. Schank [1990] writes that humans think in terms of stories, the world is understood in terms of stories, and people often approach problem-solving and new ideas by referencing stories they have lived or heard tell. Storytelling and narrative are therefore fundamental to human experience.

On the other hand, Huizinga [2001] highlights the importance of the "play element *of* culture". He argues that cultural practices are characterized by features of their game-like quality, and that humans can be defined as playful creatures; our playfulness would be shown by our curiosity, our love of diversion, explorations and wonder. Roger Caillois [apud Huizinga 2001] also states that it is through play that civilization develops. Play is an essential way of engaging with and learning about our world and ourselves.

Trying to make the two points of view converge (narrative and gameplay) seems only natural as an interesting and promising endeavour for research. Indeed, such has been the origin of the field that is usually called Interactive Storytelling (IS) or Interactive Narrative.

While IS is in no way a new research topic (efforts exist since at least the 1970s, e.g. [Meehan 1977]), interactive dramatic experience has become a central topic with the ever growing ubiquity of computers — and consequently of "interactive media"; Laurel's [1993] work being one of the catalysts for this boom.

Much discussion about the relationship and interplay between games and narratives has taken place [Aarseth 1997, Dodsworth 1997, Murray 1997, Wardrip-Fruin and Monfort 2003, Crawford 2004, Glassner 2004]; and many names have been coined for this new "art form" that somehow combines narrative and gameplay. It has been called "game-story", "story-game", ractive [Stephenson 95], cyberdrama [Murray 1997], and story environment [Glassner 2004]. Aarseth [1997], for example, uses the term *ergodic literature* to refer to "dynamic texts where the reader must perform specific actions to generate a literary sequence, which may vary for every reading".

While agreeing that to tackle this field of research we should better understand the differences (and similarities) between games and stories, the focus should not be to enforce boundaries or apply labels, but — as Murray [2004] puts it — to enhance and stimulate practice in this new medium.

Digital games have gained wide acceptance and became a research field on their own, but the field of IS remains unsettled, still presenting many open issues.

Different approaches have been tried to reach the goal of integrating storytelling and entertainment, such as works of interactive fiction and adventure games, but none succeeded to fully match expectations. One of the main challenges of interactive storytelling is still the generation of stories that are both coherent and interesting, while allowing meaningful user interaction during their creation.

Even though it is not possible to define the ideal model for a good story, as the quality of a story depends heavily on the tastes and expectation of those watching or participating in it, one of the goals here is exactly to find models that might be used in specific situations, fulfilling the expectations of a good percentage of the interested audience.

Most approaches to interactive storytelling do not propose to address the problem of what constitutes a proper story space [Magerko 2007] or how to model the characteristics of events pertaining to a plot, preferring to focus, perhaps too strongly, on more controlled environments and stories. We feel that more generative approaches are essential for the field of interactive storytelling to reach a wider appeal and become truly successful.

1.1. Motivation and Thesis Goal

LOGTELL [Pozzer 2005] provides a good platform in this regard, as it uses a conceptual model of a genre to generate a variety of coherent stories. Having decided to explore the possibilities provided by LOGTELL, we initially set to work in three fronts: a) analyse it from a software engineering point of view; b) improve its graphics engine to allow richer plot dramatization; and c) add mechanisms to support interaction with the story during dramatization.

The module responsible for the dramatization of a plot in the prototype version of the system (Drama Manager) did not handle "story-level" decisions, employing a too low-level breakdown of the plot events to deal with character behaviour and animation.

The behaviours used a simple, albeit effective, "actor model" rigidly integrated into the Drama Manager inner workings. This orientation, together with the fact that LOGTELL used an in-house 3D engine, made it very difficult to extend it in the directions initially intended, so it was decided that it was not worth while to dedicate much effort to graphical improvements to the system until LOGTELL transitioned to another graphics engine (which was being discussed at the time).

During this effort, other approaches to extend the system were considered: breaking down the planning into two levels, to change the planning system to an HTN planner, to integrate an AI middleware as a way to add new more flexible

character behaviours, a better breakdown/separation of concerns in the system, etc.

Meanwhile, after a review of bibliography about interactive storytelling and related areas, the potential of LOGTELL's conceptual model became more apparent to us. So the focus changed to extending the model's expressiveness, exploring the possibilities of generating a large variety of coherent stories through the use of the plan-recognition/plan-generation paradigm over the genre model. Early Artificial Intelligence research had already found that drawing from repositories of commonly used schemes (scripts, in the sense of [Schank and Abelson 1975]) may offer a less costly alternative than constructing plans from scratch. In LogTell-R we were able to combine automatic phases of plan-generation, as already provided by LOGTELL, with plan-recognition as a source of inspiration for user interaction.

Our approach to this exploration is oriented firstly to finding sound methods to organize and combine events, in ways that may confer enough dramatic power to the narratives being generated. In our attempt to extend the conceptual model with this purpose in mind, we drew not only from Artificial Intelligence, but also from Semiotics [Saussure 1967; Chandler 2002], an academic discipline that has been gaining increasing recognition for its contribution to the most diverse areas. In fact, Semiotics has an overarching scope, since it involves the study of signs in general. We are particularly indebted to research on the so-called four master tropes [Burke 1969], which, together with Saussure's seminal work on the syntagmatic and paradigmatic linguistic dimensions, led us to identify the four event relations that are central to our work.

Also, as a longer-term objective, we propose to achieve a unified system that can handle both author and player interaction. We feel that addressing both problems is essential for the field.

1.2.Contributions

This work aims specifically at the following goals (more details on the specific contributions are provided in Chapter 8):

- Analyse the available literature on different efforts to bridge the division between narrative and participation in digital storytelling, giving special attention to generative systems and how to enable the creation of an expressive story space.

- Apply the plan-recognition/plan-generation paradigm to storytelling, by adding a mechanism for plan-recognition over a hierarchy of typical plans to help the interactive creation of plots in LOGTELL (along with the existing plan-generation mechanism); this feature furnishes an alternative way to derive plots, allowing the use of the hierarchy as guidance for prospective authors.

- Enhance the expressiveness of the conceptual model of an intended genre, by extending it to encompass the four relations between events identified in [Furtado 2008]; which in turn are connected to the four master tropes of semiotics [Burke 1969]. In particular, additional support is provided for meronymic and antithetic relations in order to increase the flexibility of the story space.

- Help authors to adequately chain events into a narrative structure, and to more easily visualize and understand the space of stories that can be generated by the conceptual model through the manipulation of the hierarchy of typical plans, in a proof-of-concept editor that utilizes the Plot Manipulation Algebra (PMA) defined in [Karlsson and Furtado 2009].

- Propose a unified architecture that makes use of the implemented features, with minimal change, to support both author and player interaction in an interactive storytelling system.

1.3. Thesis Structure

This thesis is organized in the form of a collection of articles[1] and, as such, some repetition of figures, related work, and pieces of text may occur. Also, as the articles were written in a span of five years, changes in our approaches and formalism show up. The article bodies are reproduced in full, with only minor modifications to the original text to correct eventual grammar errors and to conform to the mandatory thesis layout. To each article/chapter a small preface was added to give its context and ease understanding of the thesis as a whole.

Chapters 2 and 3 (based on [Karlsson et al 2009b], which expands on previous work) present a bibliographic review of story generation systems, story models, and methods used to create stories in different media, along with a breakdown of the problem of creation/narration of stories into its four sub-components.

Chapter 4 describes our first experiments and extensions to the LOGTELL system in order to support the use of the plan-recognition/plan-generation paradigm in plot composition and adaptation [Karlsson et al 2006a, Karlsson et al. 2006b].

Whereas LOGTELL's original version [Pozzer 2005, Ciarlini et al. 2005] only dealt with syntagmatic and paradigmatic relations between events in the generated plots, Chapter 5 describes how we extended the conceptual model in LogTell-R to also deal with meronymic and antithetic relations [Karlsson et al. 2010a] — thus covering the four relations described in [Furtado 2008]. The core element of this implementation is the use of a hierarchy of typical plans, which can be used in plan-recognition but also helps in structuring the possible

1 Even though other articles were written during the doctorate, only the texts relevant to digital storytelling are included in this collection.

narratives, defining the story space of the system. A simple editor is available for creating such hierarchies, using the Plot-Manipulation Algebra (PMA), which is discussed in the sequel.

Chapter 6 is based on [Karlsson et al 09a] and examines plot composition at a logic design level, an intermediate stage that comes next to the conceptual level wherein the intended narrative genre is specified. An abstract data structure is proposed to represent plots, together with an algebra (PMA) for manipulating the data structure. The basic operators of PMA are introduced in view of the four fundamental relations between events previously described. Further details about the algebra can be found in [Karlsson and Furtado 2009].

Chapter 7 presents a technical report on the architecture of LogTell-R and some usage scenarios of the system [Karlsson and Furtado 2010b]. Thus illustrating the use of the four described relations between events in composing and adapting a plot. Finally, Chapter 8 summarizes the contributions and suggests topics for future research work.