A Flexible Framework for the Creation of Narrative-Centered Tools*

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Abstract

To better support the creation of narrative-centered tools, developers need a flexible framework to integrate, catalog, select, and reuse narrative models. Computational models of narrative enable the creation of software tools to aid narrative processing, analysis, and generation. Narrative-centered tools explicitly or implicitly embody one or more models of narrative by their definition. However, narrative model creation is often expensive and difficult with no guaranteed benefit to the end system. This paper describes our preliminary approach towards creating the SONNET narrative framework, a flexible framework to integrate, catalog, select, and reuse narrative models, thereby lowering development costs and improving benefits from each model. The framework includes a lightweight ontology language for the definition of key terms and interrelationships among them. The framework specifies model metadata to allow developers to discover and understand models more readily. We discuss the structure of this framework and ongoing development incorporating narrative models.

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1 Introduction

To better support the creation of narrative-centered tools, developers need a flexible framework to integrate, catalog, select, and reuse narrative models. This paper describes our approach to creating such a framework.

Computational models of narrative enable the creation of software tools to aid narrative processing, analysis, and generation. These narrative-centered tools can help many types of users

1. improve awareness of existing narratives through automated processing of large corpora;
2. increase narrative understanding through detailed and semi-automated analysis; and

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3. increase narrative impact through the development of software tools to assist in narrative authoring and generation.

These tools have great potential to impact society at several levels. Narrative tutors could assist students in learning to read, write, and better express themselves through narrative. Narrative-aware workspaces could assist Hollywood screenwriters, marketers, and game developers to hone their narratives and better target their products. Narrative processing tools could allow news organizations to better track and report on stories across social media.

Narrative-centered tools explicitly or implicitly embody one or more models of narrative by their definition. The model may specify narrative structure (e.g., a beginning, middle, and end), make claims about audience narrative processing (e.g., "this event will confuse many audience members"), or even predict audience responses (e.g., sales of paper towels will raise 23% in this market demographic). Models may be small and simple, such as, "begin your narration in the middle of the action," or models may be large and complex, such as a Bayesian network that predicts audience feelings of Schadenfreude or a model of plot construction using artificial intelligence (AI) planning.

Narrative is a complex phenomenon, and no one model is sufficient for all tasks; what works for radio advertisements in Brazil may not apply to existential French film. Models arise from traditions with vastly different viewpoints [16], such as narratology, sociology, anthropology, psychology, marketing, or educational theory. Furthermore, each singular task may benefit from multiple models; a screenwriting application may use models of plot structure, character emotions, tempo, dialog, special effects, and set blocking, while a comic design tool may use models of visual layout, character backstory, and situational humor.

Currently, despite years of progress in computational narrative (c.f., [13, 5]), most authors still use office productivity tools, such as a word processor. There are few commercially available tools that embody significant narrative models. Part of this is due to the high software engineering overhead of designing, implementing, and leveraging narrative models. Often, these are complex software components that must undergo significant testing to ensure functionality. This cost imparts little proven benefit to justify these high expenses, and no best-practices formal method to codify these theories has been established. The framework presented in this paper begins to address these needs.

2 Related Work

Computational narrative models have been created for over 35 years; for example, the TALESPIN system is often attributed as one of the earliest computational narrative programs [14]. See [13] and [5] for reviews. Two recent workshop series, Computational Models of Narrative and Intelligent Narrative Technologies, have collected much of this work. Prior to the computational work, narrative structuralists began creating formal models of narrative structure, e.g., [17]. However, little effort has been undertaken to date to create open frameworks to incorporate, compare, and use models, especially towards the creation of tools.

There have been several efforts towards the creation of narrative ontologies. Wolff, Mulholland, and Collins [23, 15] created a narrative ontology and surrounding system for the exploration of museum and heritage institution narratives. Tuffield, Millard, and Shadbolt [21] discuss ontological models of narrative fabula, szujhet, and medium, embodied in part in the OntoMedia system [12]. Peinado et al. [18] created an ontology of Propp's model [17], and others have employed ontologies for narrative generation as either specifications of narrative elements or as common-sense databases [3, 11, 4]. Notably, Zarri [24] presents a Narrative Knowledge Representation Language (NKRL). Whereas NKRL presents a full knowledge representation language with associated reasoning to represent the meaning of narratives, the framework presented in this paper does not make definite claims about narrative structure or useful reasoning types; instead, these decisions are left to the individual models of narrative that are part of the framework.

As a particular example of a related system, Finlayson's Story Workbench [6] provides an extensible framework for creating textual narrative annotation tools. This type of system and tool is complementary to the goals of the framework, and is precisely the type of development the framework is intended to support. The annotations provided by the Story Workbench can be directly translated to framework ontology terms, and vice versa, and other systems can more readily make use of these annotations through their incorporation into the framework.

3 The SONNET Narrative Framework

In this section, we describe our progress toward developing a flexible and extendible common ontology and narrative framework that applies to a wide range of potential models of narrative. As defined below, the framework consists of a unified upper-level ontology and an application programming interface (API) against which developers can create models that process narratives annotated with ontology terms. The framework provides a facility to collect, store, and reuse ontology terms and models.

This framework was developed as part of our Studies to Operationalize Neuro-Narratology for Effective Tools (SONNET) effort under the Defense Advanced Research Projects Agency (DARPA) Narrative Networks (N2) program. The goal of N2 is to integrate narrative research from a broad selection of sources. SONNET is a program of research intended to integrate cutting edge research from narratology, computational narrative, and neuroscience to develop tools to assist the layperson in creating impactful narratives. Hence, we refer to it as the SONNET narrative framework, or just 'the framework' for the purposes of this paper.

The framework serves multiple purposes in our research efforts. The framework:

- supports a wide range of tools for narrative processing, analysis, and generation
- supports the development and empirical testing of hypotheses about narrative and audience responses
- enables researchers to identify and codify relationships between narrative research results
- enables researchers to compare and contrast narrative research results in a formal or semi-formal manner
- supports reasoning about the causal chain from narrative element to audience behavior

3.1 Overview

The framework addresses several requirements. First, it considers several types of features:

1. narrative characteristics such as plot patterns or discourse tempo;
2. audience characteristics such as demographics and state of mind;
3. situation characteristics such as to whom, where, when, and how the narrative is delivered; and
4. likely audience responses such as changes in behavior or detectable changes in physiology.

Second, it supports focused applications with models that apply specific domain knowledge. Third, to enable the broadest application possible, it allows for a wide range of model types with few restrictions on model expression.

Figure 1 shows a depiction of a tool-centric computational narrative ecosystem. For example, consider a tool to help parents created educational storybooks for their children. At

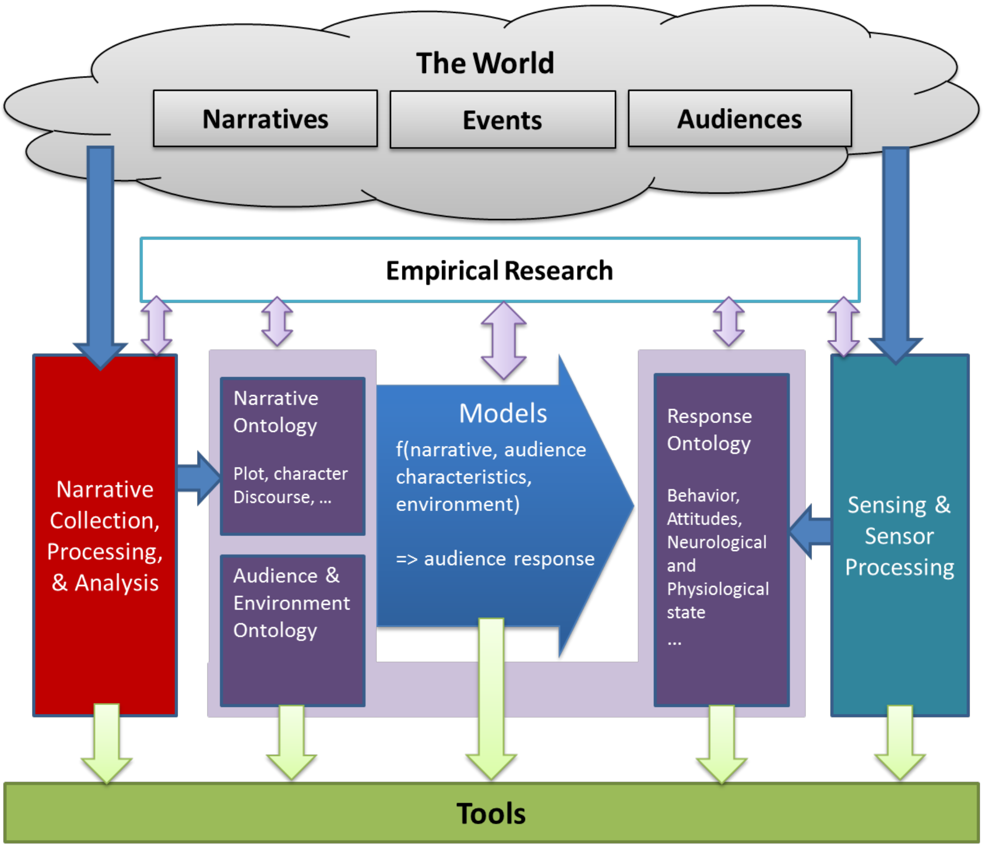

Figure 1 A depiction of a tool-centric computational narrative ecosystem.

the top, narratives, events, and audiences in the real world (such as cultural fables, events in the child's life, and elements such as age group or gender) enter the system through narrative collection; processing and analysis occurs on the left (such as extant databases children's books and fables) and sensing and sensor processing occurs on the right (such focus groups with surveys or even devices such as eye tracking or heart rate monitors). Through these pathways, real-world data is either automatically collected or input manually.

The framework is the central component, consisting of the ontologies (purple boxes) and models (blue arrow). The ontology is an extensible, flexible framework for capturing relevant concepts; that is, it defines the key terms used by the models. In children's books, this may include plot structures, popular characters, morals, and themes. Sections of the ontology that are concerned with specific domains (e.g., sharing or brushing your teeth) are linked by a common upper ontology. The models themselves are mappings between elements of the ontology. A model may map a particular narrative element and audience demographic to an expected audience response. For example, a model may be "two year old children are excited by characters they recognize from other narratives if the character's name is often repeated in the text." However, the models are not solely relegated to the "narrative + audience = response" formula; they may also describe the workings of sensors or narrative processing algorithms. For example, a model may map a change in physiology (increase in heart rate) to a related emotional response (excitement).

In the middle, empirical research may be performed to develop and evaluate any the framework components, such as the effect of name recognition on narrative engagement in

- Type name – name of the type
- Description – a description of the type denoting which entities may be classified as this type
- Super types – types from which this type derives, a type includes all the aspects of its super types
- Attributes – aspects of the type
- Parts – components of the type
- Source – reference material from which the type was derived or the origin of the type definition
- Comments – additional notations

- Type: Bicycle
- Description: Something to ride
- Super type: Vehicle
- Attributes: Color
- Parts: Wheels(2), Chain, Pedals(2), Steering Wheel
- Source: Bob's Book of Bicycles

Figure 2 Left, type definition in the SONNET ontology language, Right, example type of bicycle.

two year olds. At the bottom, the ontology, models, narrative collection, and sensing may be combined into narrative-centered software tools, such as a tool for parents to create new storybooks for their children.

Our primary effort in populating the framework is to

1. conduct research to create these models and
2. support others in the community in incorporating their models.

Model validation and verification rests with the model creator. Instead, this framework provides a vehicle for empirically valid results to be incorporated into narrative-centered software tools.

3.2 Ontology Representation

In creating this framework, we surveyed ontology representations in order to select the one that best met our design goals, including RDFS, KIF, OWL, CL, CycL, KL-ONE, and WordNET [8]. Through this survey, we determined that none of the standardly available ontology representations completely fit the needs of the system, largely because the existing representations introduce complexity not required for the purposes of this framework. Instead, we developed a highly simplified ontology representation and ontology browser.

The ontology represents the definitions of the types of objects in the universe relevant to N2 and our operational communities. The definitions are both concrete entities such as "person" and abstract ideas such as "religion" or "plot structure". We have developed a lightweight ontology language to represent these concepts. Our simple ontology representation was influenced by discussions with Ibuki, Inc. about their proprietary type system. The ontology is a set of type definitions in the format described in Figure 2.

This ontology language is designed to meet the specific needs of the framework. It is lightweight, reducing overhead in ontology creation and maintenance. It is designed for collaboration, allowing others to quickly understand and edit their ontology terms. The ontology does NOT include reasoning. Reasoning is left to the models, preventing overcommitting to a single reasoning algorithm. For example, while rhythm and rhyming may be important to narrative surface text in Dr. Seuss books, reasoning surrounding these elements would be out of place in more prose-centric narratives, such as the Very Hungry Caterpillar. However, the ontology language supports translation to and from existing ontology languages (such as OWL or CL). Because each of these languages incorporates

Table 1 Top level terms in the current upper ontology.

Narrative Type	Audience Type	World Type	Sensor Type
Narrative Narrative Element Narrative World Narrative Theory Setting Character Plot Plot Event Discourse Ordering Attribution Reference Narration Technique Context Perspective Media Time	Person Group Physiology Mental State Individual Differences Behavior Personality Trait Knowledge Value	Geography Type Religion Type Communication Channel Space Framing Software Narrative Analysis Framework Rhetoric	Signal Heart Rate EEG fMRI fNIRS SCR Physiological Processes

multiple useful reasoning and modeling technologies, this approach allows the use of these existing powerful capabilities without overcommitting to a specific algorithm.

Each model is defined through ontology terms and the ontology terms are linked through a common, evolving upper ontology. We anticipate a strong benefit of the framework will be the sharing and combining of models to create products that are more than the sum of their parts. For example, character representation in Clifford books may be examined in the context of character representation in Aesop's fables. This feature enables researchers to identify connections between theories, and it enables lay persons using narrative tools to locate, use, and compose models intelligently.

Table 1 shows the current top level terms in the upper ontology. These are divided into the broad categories of narrative, audience, world, and sensor types. We anticipate the upper ontology will continue to evolve as new models and associated terms are added.

3.3 Model Representation

A model, in this context, is a relationship among terms defined in the ontology, represented in one of many forms. Models may include a simple claim, such as "repeated character descriptions make characters more memorable to young children", an IF-THEN statement, a mathematical formula, a computational function, or even a complex computation model such as a causal influence model, Bayesian net, or system dynamics model. For example, a more complex model may compute predictions for psychological impact based on audience type and plot structure. In our children's books example, this may be a Bayesian net to compute estimated recall of characters based on plot structure, child age, familiarity with characters, and gender.

Metadata is attached to the models to describe why the relationship is believed to be true, and under what conditions. For example, "findings supporting this model were observed in laboratory setting with 100 children, aged 2-4, published paper" or "this model expresses a common feature in the majority of the popular Berenstain Bear novels". This metadata allows both the users and narrative-centered tools to make informed decisions about whether to apply a model and how it may be used in any given context. Models are tagged with this metadata to aid in discovery and understanding by both developers and end users. This metadata includes: overall description, history and creation data (e.g., creator, creation date, and applications), relevant publications and summary of evidence, relevant audiences, key metrics, and a list of the ontology terms used by the model.

At the time of writing, we have integrated multiple models in multiple formats, including:

- Narrative transportation [9, 10, 22]
- Relationship between empathy-induced oxytocin response to narrative, physiological indicators and donation behavior model based on work by the Center for Neuroeconomics at the Claremont Graduate University [2]
- Karma narratives based on N2 research by Richard Gerrig at SUNY Stony Brook
- Narcocorridos, narrative Mexican drug ballads [20]
- Aristotle's Poetics [1]

3.4 Narrative Representation

Narratives are represented in the framework as narrative media with annotations from the ontology. Narrative media may include text, images, audio, and video. The annotations map a portion of the narrative media to an ontology term or terms. For example, the phrase "Once upon a time" in a children's fable may be mapped to the ontology term "Traditional Fairytale Opening", which has a definition describing the meaning and use of this phrase. Similarly, portions of images or segments of audio and video may be mapped to ontology terms. The purpose of the annotations is to enable processing by individual computational models.

As an example of complex narrative processing using the framework, we examine a hypothetical narrative tool to assist children's book authoring using plan-based plot generation (c.f., [19]). Plan-based plot generation uses plan operators, with preconditions and effects, to represent events in the plot, and it applies artificial intelligence (AI) planning algorithms to generate or complete plots to meet specific criteria. To integrate this generation into the framework, ontology terms defining each of the plan operators and the plan data structures are created. A new model is created to represent the planning algorithm, and metadata is added to the model describing the use of the planning algorithm to generate plot structures.

The software application tool integrates with the narrative framework. It prompts the user to select and incorporate plot events, inserting each event as a sentence in the working document that is annotated behind the scenes with associated plan steps, variable bindings, and plan links. The AI planner model is routinely invoked to suggest improvements to the plot for consistency or to meet aesthetic heuristics. The user works alongside the AI planner model to create a final plot.

The advantages of incorporating the SONNET narrative framework for this hypothetic tool are collected when additional models are overlaid on the narrative creation process. The tool may take advantage of models that suggest character descriptions to enhance engagement for young children. It may add additional models to enhance dramatic plot arcs, suggest illustrations, advise character dialog creation, and maintain ideal discourse tempo and length for the young audience. Each model includes its annotations from the ontology. Once these annotations are applied to the working narrative, either automatically or through user input, the respective model can process the narrative and provide its recommendations. Since the tool already has infrastructure to apply annotations and request and receive recommendations from models, development overhead is reduced for each additional model.

4 Conclusions

This paper presents a preliminary approach to creating a flexible framework to integrate, catalog, select, and reuse narrative models. The framework includes a lightweight ontology language for the definition of key terms and interrelationships among them. The framework specifies model metadata to allow developers to discover and understand models more readily, and it represents narratives as annotated media. Lightweight and flexible frameworks such as this one open the door to research community collaboration with low overhead, enabling more rapid advancements and more immediate applications of narrative research results. This framework directly supports tool development by making computational models of narrative more accessible to researchers, tool developers, and potential users alike.

Future and ongoing work includes

1. extension of the model and annotation specification to enable more standardized models where applicable;
2. development of more specific models; and
3. development of narrative-centered tools that use this framework.

A number of open questions remain for the community of researchers, tool developers, and end-users. While the framework currently enables specification of a broad set of possible computational approaches to modeling and processing narrative, which models and ontology concepts may be most useful for end-user applications? How can annotation schemes be defined to be readily applicable to a broad set of tasks? Which annotations can be automated, and which require user input? What application programming interfaces (APIs) can be created to further lessen development overhead. Addressing these questions in future versions of the framework will enable broader adoption, ultimately benefiting the end users of narrative-centered applications.

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