Narrative Intelligence (NI) – the confluence of narrative, Artificial Intelligence, and media studies – studies, models, and supports the human use of narrative to understand the world. This volume brings together established work and founding documents in Narrative Intelligence to form a common reference point for NI researchers, providing perspectives from computational linguistics, agent research, psychology, ethology, art, and media theory. It describes artificial agents with narratively structured behavior, agents that take part in stories and tours, systems that automatically generate stories, dramas, and documentaries, and systems that support people telling own stories. It looks at how people use stories, the features of narrative that play a role in how people understand the world, and how human narrative ability may have evolved. It addresses meta-issues in NI: the history of the field, the stories AI researchers tell about their research, and the effects those stories have on the things they discover.

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CHAPTER 1

Narrative Intelligence

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Introduction

People are narrative animals. As children, our caretakers immerse us in stories: fairy tales, made-up stories, favorite stories, "Read me a story!" Even when barely verbal, we begin to tell our own proto-stories. As children, narrative frameworks become an important part of the way we learn to approach the world (Nelson 1989).

As adults, we continue to surround ourselves with stories, furnishing our worlds not just with data but with meaning. We say to one another, "Have you heard? Frank and Barb had a fight. She's sick of him letting the dog on the bed. I always told him he'd get in trouble with his permissive ways with that beast." By telling stories we make sense of the world. We order its events and find meaning in them by assimilating them to more-or-less familiar narratives. It is this human ability to organize experience into narrative form that David Blair and Tom Meyer call "Narrative Intelligence" (Blair & Meyer 1997) and around which AI research into narrative coalesces.

A brief history of narrative intelligence

Given the primary importance of narrative in human experience, it is no surprise that story and narrative have long been of interest to AI researchers. In the 1970's and early 80's there was a substantial amount of interest in story understanding and generation in particular. Work in this area was particularly strong in Roger Schank's research group at Yale. Schank and his group explored

the issue of what kind of knowledge structures and process a human being must have to understand the meaning of natural language. Since the meaning of a sentence is not determinable in isolation, but requires relating the sentence to sentences around it, to prior experience, and to some larger context, the group's work quickly became focused on understanding narratives. In a series of programs, they developed a theory of the knowledge structures necessary to understand textual narratives. The story-understanding system SAM (Cullingford 1981) used scripts to capture the notion of stereotyped situations or contexts. The scripts captured the typical causal connections holding in a stereotyped situation. The story-understanding system PAM (Wilensky 1981) and the story-generation system Tale-Spin (Meehan 1977) both incorporated a notion of the goals held by characters in a narrative and the various means they have to accomplish these goals. Other work in this group included a model of ideologically-biased understanding (Carbonell 1979), the use of themes to capture aspects of stories more abstract than can be captured just with scripts, plans and goals (Dyer 1983), and a model of narrative memory and reminding (Kolodner 1984).

Work in this area generated an impressive range of systems, particularly given the comparatively primitive hardware technology to which these early researchers were limited. A pleasant discovery for later researchers in re-reading these early reports is a level of charm and wit in system design often unfortunately lacking in contemporary research. Nevertheless, these early narrative systems fell out of favor, suffering from the same fate that befell many 70's AI systems. They were intensely knowledge-based, which meant that they functioned only in very limited domains and could be made more general only by an intensive and probably eventually infeasible knowledge engineering process.

But, perhaps more importantly, as funding for AI dried up during the AI Winter, AI research became more focused on constrained problems with clear, measurable results and immediate practical utility. Researchers tried to make AI more like engineering than like a craft or an art. This required focusing on problems with discrete measurable outcomes in which it is possible to say with certainty that a program achieves or does not achieve the given objective. Yet such a research agenda rules out the ability to work on complex phenomena such as the human use of narratives precisely because the complexity of such a phenomenon rules out the possibility for complete, decisively testable models. Schank makes this clear in his description of the research agenda at Yale (Schank & Reisbeck 1981:4):

> Thus, for us, theory creation is a process of thought, followed by programming, then by additional thought, with each serving the other. Thus AI really operated under a novel view of science. Normal scientific method holds that first a theory is postulated, and then tested and found to be right or wrong. But in AI our theories are never that complete, because the processes we are theorizing about are so complex. Thus our tests are never completely decisive. We build programs that show us what to concentrate on in building the next program.

Except for occasional exceptions continuing in the Yale tradition, such as Mueller's model of daydreaming (Mueller 1990) and Turner's model of storytelling (Turner 1994), sustained work on narrative disappeared in AI.

Birth of NI

While AI research became refocused, narrative became no less important. Narrative influences simply became felt in other areas of computer science. In these other areas, narrative became an influence as part of a general move towards an interdisciplinary engagement with the humanities. For example, in human-computer interface design, the research focus moved from the hardware interface, through programming language as interface and interactive terminal as interface, to a view of the interface as a computer/human dialog (GUI's are based on this model) and a growing concern with the entire use context (including the social context) as the "interface" (Grudin 1989). This shift in the design focus has been accompanied by a shift in system design methodologies, particularly the adoption of qualitative techniques from the social sciences (e.g. ethnography) and the use of iterative design cycles and rapid prototyping. These new methodologies focus on understanding the use context and managing the inherent incompleteness of any description of that context or the system requirements (Loewgren 1995). As system designers began coping with the rich complexities of designing both for and within a cultural context, they began tapping the long craft tradition of other design fields (e.g. architecture, graphic design, industrial design, etc.) which have been successfully designing artifacts within rich cultural settings for hundreds, if not thousands of years (Winograd 1996). As the field of human-computer interaction became more interdisciplinary (e.g. borrowing anthropological and qualitative sociological techniques), it was just a matter of time before the concept of narrative was examined for interface design principles (Laurel 1991).

Other fields of CS also began tapping humanistic perspectives in general and narrative concepts in particular. For example, in hypertext research, nar-

rative ideas were incorporated, both in the broad sense of narrative as cooperative social construction (Barrett 1989) and in the narrower sense of a narrative as a story written by an author (Bolter and Joyce 1987). Within AI itself, narrative and dramatic concepts reappeared in the form of interactive fiction (Bates 1992, Murray 1998b).

Thus, during the same time period in which AI research abandoned studying complex, culturally grounded phenomena such as meaning in favor of narrowly defined problems with decisive, measurable results, other fields of CS moved in the opposite direction, borrowing and adapting modes of knowledge production from the humanities, design and the arts in order to tackle the complexities of designing computational artifacts for and within cultural contexts. And within this general move towards a humanistic/technical fusion, narrative provides a particularly rich set of ideas for informing such work. It is our contention that this engagement with narrative in other fields of CS has opened up a new opportunity for employing narrative in AI.

Specifically, this work (re)establishes the following conditions within the CS culture:

1. Research methodologies which address rich, complex research questions by employing iterative cycles (e.g. the cycle described in the Schank quote above, where one builds to know what to think and thinks to know what to build) have been revalidated.
2. Interdisciplinary technical work drawing heavily on the humanities, design and the arts has proven useful.
3. Narrative has been recognized as a particularly rich constellation of ideas for informing system design.

The time is ripe for AI to reengage narrative, to explore all the ways in which narrative intersects with intelligence of both the artificial and human varieties. Among the first groups to begin this new exploration was a loose-knit circle of interdisciplinary researchers at the MIT Media Lab (See Chapter 2). They termed this area of work "Narrative Intelligence" (NI). Researchers in the NI group pulled in notions of narrative from other disciplines into a new, creative foment.

The rest of this introduction is structured as follows. The next section, How to Read This Book, provides short descriptions of each of the chapters, organized into topic categories. The following section, Streams of Influence, describes some of the disciplines contributing to NI, and provides short discipline-specific descriptions of how the chapters in this book relate to each of these disciplines. Finally, the section Lay of the Land describes the major

themes that have emerged in research in NI and provides short theme-specific descriptions of how the chapters in this book relate to each of these themes.

How to read this book

This book came into being after we organized a symposium on Narrative Intelligence in 1999 (Mateas and Sengers 1999). We were bombarded with submissions, and at the lively and well-attended event itself it was clear that there is a large but latent interdisciplinary community of researchers out there waiting to coalesce around the term Narrative Intelligence. This book is intended to provide these researchers with a focal point: we include historical documents about NI for context (Davis and Travers, Agre, Bruner) and in subsequent chapters attempt to give a feel for the broad range of work, from rhetoric to discourse processing to computer game design, involving systems from natural language processors to interactive autonomous characters to story databases, which is currently happening in and around NI.

Given this plethora of backgrounds, perspectives, approaches, and rhetorical forms, it is important for chapters to be understood in their own contexts. We provide some of that context here. We highly suggest that you continue your tour through the book with Davis and Travers's "A Brief Overview of the Narrative Intelligence Reading Group," which explains the range of influences that form NI and prepares readers for productive engagements with a variety of disciplinary approaches.

Marc Davis and Michael Travers are two of the founders of the NI group at the MIT Media Lab, the major catalyst for much of current NI research. Their "Brief overview of the narrative intelligence reading group" is an intellectual history of the NI group, giving a historical overview of approaches to Narrative Intelligence. Davis and Travers describes how NI research came to exist at the intersection of media theory and artificial intelligence, the difficulties they ran into in trying to synthesize these two approaches, and the work they drew on in a variety of areas to develop what became known as the NI approach.

Human narrative

Marina Umaschi Bers is a researcher at the MIT Media Lab, who has built several "identity construction kits," which support children in thinking through and constructing their identities through the use of story-telling. In "We are what we tell: Designing narrative environments for children," Bers describes

how children use narrative in the context of these identity construction environments in order to explore their values. She argues that narrative functions to develop a cohesive sense of self out of diverse and potentially conflicting "subselves."

Jerome Bruner is the founder of Narrative Psychology, an area of research that focuses on how human beings use narrative to understand the world and one another. Narrative psychology insists on the importance of stories in human understanding, contrasting with statistical, logical, and abstract approaches popular in the psychological subfields most often imported into AI. As such, narrative psychology is an important resource for NI researchers who find previously used psychological importations inappropriate for their work. Bruner's classic piece, "The narrative construction of reality," reprinted from *Critical Inquiry*, describes the properties of narrative and how they are used to create understandings of the world, giving researchers an intellectual framework for bringing narrative into their systems.

Kerstin Dautenhahn is a researcher in robotics and agents who focuses on socially intelligent agents and its evolutionary origins in animals, especially primates. Dautenhahn argues that the currently fashionable study of sociality in terms of ant and other 'anonymous' societies is inadequate for understanding what it means to be a social being for humans, primates, and other animals who live in individualized societies with complex forms of social interaction. In "Stories of lemurs and robots: The social origin of story-telling," Dautenhahn relates social intelligence with narrative intelligence, arguing that storytelling has evolved in response to the social structure and social dynamics of primate communities. This means narrative forms an important part of the social glue at least for human societies and perhaps in a prototypical form in primate societies. She describes experiments in agents with a simple ability to use narrative to understand their own and others' behaviors, and work on using social robots to help autistic children to understand increasingly complex social behavior.

Brenda Laurel is one of the pioneers of Narrative Intelligence, having explored the possibility for interactive fiction in her doctoral thesis (Laurel 1986), and subsequently opened up the area of narrative interfaces with Abbe Don and Tim Oren, as described above. More recently, Laurel started a company, Purple Moon, which built software for girls. In "Vital narratives," Laurel discusses the kinds of narrative available in American culture today, arguing for the importance of kinds of narratives that allow for flexible, critical use. She analyses the kinds of relationships which narrative supports, and argues that the best kinds of narratives are inclusive and accessible, stories that can be adapted and made relevant to their listeners' lives.

Story generation

Chris Crawford is a game designer known for several early influential games (Eastern Front, Balance of Power) and for his essays on game design and interactivity (Crawford 1984, 2000). In "Assumptions underlying the Erasmatron storytelling system," Crawford describes the design assumptions underlying the Erasmatron, an interactive story system designed to allow non-programmers (e.g. artists and writers) to build interactive stories.

In "The recombinant history apparatus presents Terminal Time," Steffi Domike, Michael Mateas, and Paul Vanouse describe a novel story generation architecture which generates the spoken narrative, video sequence and sound track for ideologically-biased documentary histories which are generated in response to audience feedback.

In "Story grammars: Return of a theory", R. Raymond Lang argues for the generation of stories using a formalized story grammar. The promise of story grammars is that they provide a formal specification of what is meant by "story structure." Lang describes an implemented grammar-based story generation system called Joseph, and situates this system within the history of story generation research.

In "The Dr. K– Project," artist Brandon Rickman describes a text-based interactive narrative system. Unlike many conventional interactive fiction systems, which simulate virtual environments and then describe them to users, in "Dr. K–" the "world" of the story comes into being and changes based on the history of the interaction. As the audience selects words in the textual narrative, the object or action is brought into focus, causing the system to redescribe the object or action in more detail. Simultaneously, other descriptions may become less detailed, reverting to more generic descriptions. The scene is in continuous flux - the narrative is not unfolded in a linear manner but rather is communicated as a gestalt created by the entire interaction. Rickman contrasts the notion of simulation and fabrication. Where simulations try to provide objective, repeatable, high-fidelity experiences with an emphasis on user control, fabrications provide more indirect user control, a small number of specific viewpoints on the world, and try to expose the representational process. "Dr. K–" can be understood as a fabrication.

In "The Rise and Fall of Black Velvet Flag: An 'Intelligent' System for Youth Culture Documentary" Sheldon Schiffer describes an interactive documentary system that documents the band Black Velvet Flag. A user traverses a custom path through the documentary materials by using a visual query interface. Schiffer is particularly interested in using interactivity to maintain

the dynamism of the original source materials. He argues that maintaining this dynamism is particularly appropriate for documenting youth cultural phenomena.

Carol Strohecker, Kevin Brooks, and Larry Friedlander are builders of the interactive fiction system "Tired of Giving In," which tells the story of the US civil rights battle that began with Rosa Parks's refusal to give up her bus seat to a white man. Interaction in this system is based on the notion of the Greek chorus: different characters have different perspectives on unfolding events, and users can ask different characters to tell part of the story. In "Experiments with the theatrical greek chorus as a model for interactions with computational narrative systems," Strohecker, Brooks, and Friedlander describe "Tired of Giving In," and give psychological justification and design sketches for future systems which allow users to shape an interactive fiction and take on different roles through the use of tangible, shared objects.

Agents and narrative

In "Agneta & Frida: Merging web and narrative?," Kristina Höök, Per Persson, and Marie Sjölinder describe the design and evaluation of a concept system for weaving narrative through Web surfing, normally a disjointed series of jumps from page to page. While accompanying users along their Web surf, the characters Agneta and Frida engage in a narrative banter: making (usually sarcastic) comments about what they see on the Web page, commenting on error messages, but also discussing (and living!) their own lives in soap-opera-like vignettes: complaining about the annoying poodle that lives next door or going to the kitchen (off-screen) to make a cup of coffee. The hope is that playing a narrative alongside and connected to the Web browsing experience will help to provide an overall sense of cohesion to the user's experience of Web surfing. Höök, Persson, and Sjölinder designed new user interaction techniques to evaluate such a system, which is not focused on optimizing user functionality, but on providing users with new kinds of experiences.

Katherine Isbister and Patrick Doyle, researchers with roots in Barbara Hayes-Roth's Virtual Theater Project, argue in "Web guide agents: Narative context with charachter" that agents can give human users richer experiences of virtual environments and the Web by telling users stories about the virtual sites they visit together. They analyze the behavior of human tour guides – what sorts of stories they tell, how they decide when and when not to tell stories, how they respond to the cues audiences give them in response. They describe two

systems that give tours: one takes humans on a virtual tour of a Japanese castle, the other takes visitors on a tour of a virtual museum.

Sengers employs a cultural-theoretic analysis of the technical assumptions underlying autonomous believable agents to diagnose why the behavior of such agents is often incomprehensible to a human observer. The technical practice of breaking down agents into black-box collections of weakly interacting behaviors results in a lack of behavioral coherence, that is, schizophrenia. The analysis of narrative properties provided by Brunner's narrative psychology (Bruner 1990, 1991) is then used to inform an alternative methodology for the design and implementation of believable agents, a methodology that makes such agents "readable" to a human observer by providing the appropriate cues for inferring a coherent intentional state.

Andrew Stern is a researcher in interactive fiction and believable agents. He is a co-creator of Virtual Petz, one of the first games that allows users to play with (seemingly) intelligent creatures with their own personalities. In "Virtual Babyz: Believable agents with Narrative Intelligence," Stern argues that narratives ("mini-stories") can in fact emerge from the interactions between characters who are modeled as autonomous agents. He describes the engineering and design techniques that were used in order to support the development of narrative in the product Virtual Babyz.

Part IV: Analyzing the stories we tell

Philip Agre's essay "Writing and Representation" was an influential early document within the NI Group at the MIT Media Lab. Agre argues that much work in symbolic representation in AI is influenced by a writing or "text" metaphor which sees representations as effortlessly, without any work on the part of the possessor of the representation, carrying meaning in a context-independent manner. This view of representation has created a series of unsolvable technical impasses within AI. Humanistic critiques (e.g. deconstruction) of the notion of text as a context-independent carrier-of-meaning have revealed that the meaning of a piece of text is a fresh problem in every new context; this meaning is actively constructed by the "user" of the text. Agre explores how this alternative account of writing and text could be used to inform a new approach to representation within AI.

In "Stories and social networks," Sack looks at the interrelationship between stories and social relationships on the internet: which stories get re-told, who cites whom and in what way. He aims for a middle ground between computational linguistics, which he argues generally looks only at the utterances of

individuals without concern for their social context, and sociology, in which social networks of storytelling are studied while often ignoring the form and content of the stories involved.

Streams of influence

One of the central aspects of NI work is its inherent interdisciplinarity. If narrative is indeed, as many argue, a fundamental organizing principle of human experience, then it is unsurprising that many different disciplines have an interest in narrative. Work in NI has drawn on conceptions of narrative from many of these sources, including the following. At the end of each discipline description is a list of the papers in this volume which relate to that discipline.

Art

In art, narrative is understood as one, rather powerful, form of representation. Much of contemporary art practice involves self-consciously questioning representational modes, exploring the boundaries, breaking the representation, questioning whose power is being preserved by a representational mode, and hybridizing modes in order to create new ones. Thus, when engaging in narratively-based work, artists rarely tell straightforward narratives employing the standard narrative tropes available within their culture, but rather ironize, layer, and otherwise subvert the standard tropes from a position of extreme cultural self-consciousness. For those studying NI, artistic practice is a useful methodological resource as a way to expose and explore the often unarticulated cultural machinery supporting narrative representation.

In "The recombinant history apparatus presents Terminal Time," Domike, Mateas and Vanouse play with the narrative structure of traditional documentary form by building a system which endlessly replicates this form.

In "The Dr. K– Project," Rickman describes a narrative landscape which, rather than having a mimetic, independent existence, is created in response to audience interaction.

In "The Rise and Fall of Black Velvet Flag: An 'Intelligent' System for Youth Culture Documentary," Schiffer is concerned with maintaining the narrative openness of raw documentary material. He draws on New Media art theory such as Lev Manovich's discussion of database culture and Peter Weibel's discussion of the variable virtual image.

Psychology

In psychology, narrative is thought of as a way in which humans make sense of the world. This notion is particularly advanced in Jerome Bruner's work on narrative psychology (Bruner 1990, 1991). Bruner argues that narrative is fundamental to human understanding of intentional behavior, i.e. that humans make sense of intentional action by assimilating it into narrative structures. This argument is used as a basis for making systems from interfaces to intelligent agents more understandable, by communicating in ways that are easy to assimilate to narrative (Don 1990, Sengers 1999).

In "The narrative construction of reality," Jerome Bruner describes the fundamental properties of human narrative, used as a basis by NI researchers for understanding how to make narrative a part of computational systems.

In "Stories and social networks," Sack explores narrative as a "technology of the self," providing tools that support analysis of identity construction through the telling and re-telling of stories within a social group.

In "Agneta & Frida: Merging web and narrative?," Persson, Höök, and Sjölinder address the human drive to create coherence out of disparate data.

In "Web guide agents: Narrative context with character," Isbister and Doyle analyse the use of narrative by human tour guides to make unfamiliar environments understandable and interesting.

In "Stories of lemurs and robots: The social origin of storytelling," Dautenhahn describes the phylogenetic origins of human narrative intelligence in primate social intelligence. She underlines the importance of telling stories to construct an autobiography, the groundwork for a sense of self. She describes problems in social and narrative intelligence in autistic people, and proposes the use of robots in therapy to develop social and narrative intelligence.

In "We are what we tell: Designing narrative environments for children," Bers motivates and describes the use of narrative in identity construction kits, virtual environments which help children to develop a coherent sense of self and their values.

In "Schizophrenia and narrative in artificial agents," Sengers uses the principles of narrative psychology as derived from Bruner in order to construct artificial agents which are narratively understandable to human users.

Cultural studies

In cultural studies, narrative is studied as a way in which a culture structures and propagates knowledge. Because humans quickly internalize narrative, it is

an important form of collective knowledge and can be a basis for ideological manipulation. NI researchers using this concept of narrative are often interested in social or collective forms of narrative and in uncovering hidden narratives. This study of narrative can be reflexively applied to AI research itself, leading to transformations of AI practices. That is, an analysis of the narrative structures and metaphors used to tell the story of progress within AI can illuminate systematic problems caused by these narratives and point the way to new research approaches (Agre 1997; Sack 1992; Sengers 1998; Mateas 2001).

In "Writing and representation," Agre draws on cultural-theoretic analyses of representation to explore unexamined assumptions regarding representation in AI.

In "Vital narratives," Laurel analyses the cultural roles played by different kinds of narratives. She argues that the inflexibility of certain kinds of narrative, such as fundamentalist religious narratives, creates the potential for a great deal of unproductive cultural conflict, while in other cases potentially helpful narratives such as scientific narratives are hindered because they are not made relevant to people's everyday lives. She argues that we need to make ethical decisions about what kinds of narratives, both interactive and noninteractive, we are creating, arguing for flexible, inclusive narratives.

In "The recombinant history apparatus presents Terminal Time," Domike, Mateas and Vanouse explore the role that ideology plays in the construction of history by building a system which caricatures ideologically-biased historical reasoning.

In "The Rise and Fall of Black Velvet Flag: An 'intelligent' system for youth culture documentary," Schiffer explores the role of youth culture in the construction of identity. Narrative constructions of youth culture must be responsive to massive change on the part of the subjects (who in turn are the audience) of this identity formation process.

In "Stories and social networks," Sack uses tools from computational linguistics to support media-studies analysis of social responses to mass media. His work is based on an understanding of the importance of narrative in people's daily lives, and the agency of social groups in retelling and reincorporating cultural narratives. A novel part of his approach from a cultural-studies perspective is that he creates a tool for cultural studies that is also usable by the people being studied.

In "Schizophrenia and narrative in artificial agents," Sengers argues for the similarity of the perspectives of behavior-based artificial agents and institutional psychiatry using the tools of cultural studies. She argues that technical problems in the coordination of behaviors can be traced historically to

symptomatic, atomizing approaches to understanding human subjectivity. She builds on the arguments of the anti-psychiatric movement of the 60's to argue that human subjectivity should be represented in artificial agents using a hermeneutic approach which includes narrative.

Literary studies

Literary studies are particularly concerned with analyzing the properties of stories as narrative. These properties can then be used as a basis for story-generation or understanding systems. For example, Vladimir Propp's analysis of the structure of folk tales (Propp 1969) has served as an inspiration for many AI researchers (e.g. Meehan 1977, Turner 1992, Weyhrauch 1997).

More generally, literary studies and literary theory embrace an enormous spectrum of perspectives on story, narrative, and their function in our culture, from Aristotle's theory of poetics to New Criticism to speech act theory to structuralism to Reader Response theory to postmodernism and beyond. Each of these strands involves novel ways of thinking about narrative and its place in human experience that can be tapped for work in NI – the surface has barely been scratched.

In "Story grammars: Return of a theory," Lang provides a brief history of story grammars, a structuralist attempt to formally capture the structure of folktales within a given culture.

In "Vital narratives," Laurel analyses narratives along four different axes: the kinds of relationships they support, their relevance to people's daily lives, the strategies they help fulfill, and their epistemological value.

Drama

Drama is the performance of stories in front of an audience in real-time (i.e. plays and movies). Dramatic stories have different properties from literary stories (i.e. novels); following Laurel (Laurel 1991), dramatic stories have the properties of enactment, intensification, and unity of structure, vs. literary stories which have the properties of description, extensification, and episodic structure. Given the affinity between drama's focus on action and the action-based, real-time, responsive behavior of interactive computer systems, researchers have begun tapping the dramatic tradition, particularly within the areas of interface design and interactive drama (Laurel 1991, Bates 1992, Hayes-Roth, van Gent, and Huber, 1997, Mateas and Stern 2000, Mateas 2000).

In "Agneta & Frida: Merging web and narrative,?" Persson, Höök and Sjölinder use inspiration from film theory to design characters for a narrative interface.

NI is humanistic AI

As you might imagine, this highly divergent list of influences (as well as multiple understandings and definitions of the concept of narrative) has led to a healthy foment in the field. While it is not unusual for AI researchers to draw from a wide variety of other fields for inspiration, it is unusual for those fields to be largely humanistic. We believe this is a special source of interest for NI: it is a field where not only scientific but also humanist notions of experience and humanity fruitfully inform technological conceptions.

The lay of the land

Drawing on a diverse range of influences, researchers have (often independently) explored a wide variety of topics relevant to NI. In the process, several common themes have emerged. At the end of each theme description is a list of papers which relate to that theme.

Narrative interfaces

Several researchers in the field of HCI argue that narrative should be used as a basis for human-computer interfaces (Don 1990, Laurel 1991). If humans often make sense of the world by assimilating it to narrative, then it makes sense to design our systems so as to allow people to use their well-honed narrative skills in interpreting these systems. For example, Don (Don 1990) borrows concepts from the oral storytelling tradition to organize the interface for a multimedia knowledge base. Specifically, she describes three properties of oral storytelling that can guide interface design: storytellers adapt the story to the reactions of the audience, information such as names and lists are embedded within the storyline so that the audience experiences this information as events unfolding in time, and characters with predictable traits are used to prime expectations. Laurel (Laurel 1991) uses the analytic categories of Aristotelian dramatic theory (i.e. spectacle, song, diction, thought, character and plot) to organize interface design.

In "Agneta & Frida: Merging web and narrative?," Persson, Höök and Sjölinder create an interface plug-in which is intended to help people create a narrative understanding of a non-narrative interface, i.e. the Web. In evaluating the system, they develop new HCI methods for evaluating narrativity based on metaphor analysis.

In "Web guide agents: Narrative context with character," Isbister and Doyle construct interface agents as characters who guide users through unfamiliar locations, providing both social context and narrative content.

Narrative agent design

The HCI argument that systems will be more understandable with narrative presentation extends to systems involving artificial agents. Since, as narrative psychologists argue, humans use narrative in particular for understanding intentional behavior, several researchers argue that agents will be more comprehensible if their visible behavior is structured into narrative (Sengers 1999; Lester & Stone 1997). This generally involves the construction of agent architectures that allow agents to make behavioral choices based on the narrative structure of the resulting behavior, often including transition behaviors that knit the agent's various activities into a coherent, narrative whole.

In "Schizophrenia and narrative in artificial agents," Sengers describes such an architecture for narratively understandable agents.

In "Virtual Babyz: Believable agents with narrative intelligence," Stern describes agents that are designed to allow a narrative structure to emerge from their behavior as they act over time.

Agents that use narrative structure

If narrative is one central component of human intelligence, then it should also play an important role in artificial agents which model aspects of human intelligence (Schank 1990; Dautenhahn & Nehaniv 1998). Roger Schank, for example, has developed a model of the interrelationship between stories and memory, describing how stories are understood and how they are recreated from the remembered "gists" of stories. Elsewhere and in "Stories of lemurs and robots: The social origin of storytelling ," Kerstin Dautenhahn argues that human (and possibly animal) experience in the world is shaped by our autobiographies, narratives we tell ourselves about our past and the pasts of other agents (Dautenhahn 1998).

In "Web guide agents: Narrative context with character," Isbister and Doyle describe agents that can use special annotations on web sites to gain access to narrative structure of information and to be able to relay this to human users.

Support for human storytelling

Since stories are an important part of human life, several researchers have begun building systems that support people in telling stories to one another. Some of these systems, such as Kimiko Ryokai's Storymat (Ryokai & Cassell 1999), record and play back stories that people have told. Others, like Marina Umaschi Bers's SAGE Storytellers (Umaschi 1997) and Kevin Brooks' Agent Stories (Brooks 1997), allow people to create their own interactive storytellers and stories.

In "Assumptions underlying the Erasmatron storytelling system," Crawford describes how the Erasmatron is specifically designed to ease the burden for the non-programmer of interactive story design.

In "Agneta & Frida: Merging web and narrative?," Persson, Höök, and Sjölinder aim to support human narrative understanding of the normally non-narrative Web.

In "Stories of lemurs and robots: The social origin of storytelling," Dautenhahn describes a robotic system for helping autistic children to be able to understand human behavior, providing them with training for narrative intelligence.

In "We are what we tell: Designing narrative environments for children," Bers describes several virtual environments based on constructionist learning principles which can be used by children to explore and develop their identities and values in a community, using narrative as an essential element for developing a coherent sense of self.

Story database systems

Some researchers have found it useful to design systems which allow humans to access databases of stories. Presenting information in the form of narratives, they argue, makes it easier and more pleasant for people to process the information. Schank (Schank 1997) has built a training system, Ask Tom, on this principle. It contains a database of stories describing how people have handled commonly occurring problem situations; these stories are triggered by the system when the trainee faces a similar situation. Another example of this kind of work is IBM Research's project on Knowledge Socialization, which looks at

– among other things – ways in which story databases can be used to transfer informal knowledge (Lawrence & Thomas 1999). Cassell and Smith's Victorian Laptop combines a story database with a storytelling support system. As people write their own travel stories, the system retrieves matching stories from a database of Victorian travel narratives, allowing them to compare their experiences with those of travelers from the past (Cassell & Smith 1999).

Story-understanding systems

Story-understanding systems seek to model the processes by which a human "understands" a story. "Understanding" is usually operationalized as the ability to answer questions about a story where the answers are not explicitly given within the story, or as the ability to paraphrase or summarize a story. In order to perform these tasks, story-understanding systems form representations of stories more amenable to manipulation than the surface form, make connections between the stories and some context or background knowledge, and possibly have models of story event importance. Research in story understanding began during AI's classical engagement with narrative (see the section "A Brief History of Narrative Intelligence" above). Even after the shift in AI research agendas following the AI Winter, a small stream of such work continued (e.g. Cox 1996). This body of work plays an important role within NI. By exploring what it means to be the kind of system (either natural or artificial) that understands stories, this work can help inform the design of agents and interfaces that make use of narrative. For example, Sack's work on automatically understanding ideological bias of news stories highlights the importance for narrative of understanding not only the content of what is said, but also the viewpoint that leads it to be told in particular ways (Sack 2001).

In "Stories and social networks," Sack develops a story-understanding system which focuses not on the story itself, but on understanding how people use stories socially and to construct identity.

Story generation systems

Storytelling systems seek to model the knowledge and processes necessary to tell a story. Following Bailey (Bailey 1999), work in storytelling systems can be divided into three major groups: author-centric, story-centric, and character-centric systems (Bailey refers to character-centric systems as world models). Author-centric systems model the thought processes of an author. Character-centric systems model the goals and plans of characters; stories result from

characters pursuing their autonomous goals. Story-centric systems model the structural properties of stories themselves (viewing the story as an artifact); the system tells stories by manipulating this structural artifact.

Like story understanding, storytelling work also began during AI's classical engagement with narrative. Interestingly, the three perspectives outlined above all emerged during this classical engagement at roughly the same time. Perhaps the most famous early storytelling system is Tale-Spin (Meehan 1977). Tale-Spin is a character-centric system, modeling the goals and plans of animal characters taken from Aesop's fables. Ani (Kahn 1979), an author-centric system, generates an animation (using a square, triangle and circle to represent characters) telling a simplified version of Snow White. The system is given a high level script describing the authorial goals for the story (what should be conveyed); given this script, it makes all the detailed animation decisions necessary to tell the story. Rumelhart (Rumelhart 1975) takes a story-centric approach, capturing the notion of story as a story grammar. For more detailed descriptions of the history of story-telling systems, see Lang in this volume (Chapter 12).

All three storytelling approaches tend to utilize some form of combinatorial search over a space of primitive story elements. Elliott (Elliot 1998) has explored an alternative approach. His system, while using a fixed script, tells different stories by narrating the stories with different emotional emphases. The emotional behavior of the narration agent is generated by the Affective Reasoner, a cognitive appraisal model of emotion. Elliott's work demonstrates that a storytelling system can leverage the interpretive capabilities of a human observer, in this particular case the ability to understand motivations and emotions.

In "The recombinant history apparatus presents Terminal Time," Domike, Mateas and Vanouse describe a system which generates ideologically-biased histories in response to audience feedback. While Terminal Time is audience interactive, its architecture is influenced more by work in story generation than work in interactive fiction and drama.

In "Story grammars: Return of a theory," Lang describes an implemented story grammar that generates stories in the style of ethnic folktales.

Interactive fiction and drama

The field of interactive fiction and drama seeks to build systems that let the audience experience the story as an interactive participant (this includes, but is not limited to, being a first-person protagonist). System – building work in this

area includes approaches that don't specifically make use of AI techniques, such as hypertext fiction and text and graphical adventure games. These approaches have been quite fruitful for exploring the nature of interactivity and the structural possibilities of interactive narrative (Murray 1998b). But for the purposes of this brief overview, we will focus on AI-based approaches to interactive fiction and drama.

Most of the work in interactive drama has approached it from an autonomous-agents perspective. The focus has been on building believable agents that can play roles in stories. The Oz Project built an agent architecture (Loyall & Bates 1991; Loyall 1997) including a model of emotion (Reilly & Bates 1992; Neal Reilly 1996) to support the construction of autonomous characters. Hayes-Roth built agents that improvise activity around a fixed script (Hayes-Roth, van Gent & Huber 1997). Blumberg was originally motivated by the ALife goal of building computational instantiations of ethological models of action selection (Blumberg 1994), but more recently has focused on building architectures to support the construction of characters (Kline & Blumberg 1999). Most of the believable agents architectures make use of some reactive action-selection framework, though there has been some work on using planning techniques to ease the authorial burden (Rizzo et al. 1998).

There has been less work on building systems to support interactive plot. Some work has focused on systems that provide high level plot guidance to believable agents. For example, Weyhrauch (Weyhrauch 1997) built a dramatic guidance system that issues high-level commands to Oz believable agents. Blumberg and Galyean (Blumberg & Galyean 1995) explored the concept of a director giving commands to autonomous characters at multiple levels of abstraction. Other work has focused on tracking the user's progress through a fixed plot, using user actions to trigger the next part of the story. For example, Galyean (Galyean 1995) built a system that uses cinematic techniques adapted to virtual reality to guide a user through a plot. Pinhanez (Pinhanez 1997) built a system that uses a temporal calculus to trigger story events given user actions. Mateas and Stern (Mateas & Stern 2000) are building an interactive drama system which blurs the distinction between strongly autonomous characters and high-level plot control by intermingling believable agent behaviors and plot constructs.

In "Assumptions underlying the Erasmatron storytelling system," Crawford describes the Erasmatron, a system for authoring and playing interactive stories.

In "The Dr. K– Project," Rickman describes a text-based interactive narrative system based on a historical account of two murderers in 1820's Edinburgh.

In "Virtual Babyz: Believable agents with narrative intelligence," Stern describes a character-centric approach to interactive fiction, constructing interactive agents that allow simple plot to emerge from their interactions with one another and the user. He concludes that it is possible to use this to generate loose interactive plots, but that more support for top-down management of plot is needed in order to create tight, well-crafted plots.

Digital interactive video

For digital interactive video, systems automatically construct videos from a database of video clips with interactive guidance from the user. These are closely related to interactive storytelling systems, but face their own range of technical problems because of the use of video material. In Davenport's Autonomist Storyteller System (Davenport & Murtaugh 1997), each video clip is annotated to specify its potential run-time use in a narrative sequence. A search engine assembles the clips into a narrative sequence in real-time. In Synthetic Interviews (Marinelli & Stevens 1998), annotated clips are retrieved in response to utterances processed by a speech recognition engine. This allows a user to have a conversation with video characters; this conversation can be part of a story arc.

In "The recombinant history apparatus presents Terminal Time," Domike, Mateas and Vanouse describe a system which constructs ideologically-biased documentary histories from a database of video and audio material.

In "The Rise and Fall of Black Velvet Flag: An 'intelligent' system for youth culture documentary," Schiffer describes an interactive video system which allows a user to explore their own paths through a database of documentary materials.

Narrative for meta-analysis

AI researchers are people, too. As such, narrative plays an important role in AI research. Some researchers, particularly in cultural studies, study the kinds of narratives AI researchers use in talking about their own work, and how such narratives are woven into choices about what kind of research is worth pursuing (Hayles 1999; Helmreich 1998; Doyle 1997; Sack 1997). A number of AI researchers in turn believe that studying the narratives AI researchers themselves tell can lead to a better self-understanding for AI, and, in turn, yield better AI research (Agre 1997, Sengers 1998, Mateas 2001).

In "Writing and representation," Agre examines the stories AI researchers tell about human representation use, and counters with alternative stories about representation use.

In "Schizophrenia and narrative in artificial agents," Sengers critically analyses the way in which AI researchers talk about their agents, discovering similarities to descriptions of schizophrenic patients. These stories reveal the extent to which AI researchers think of and build their agents as simple mechanisms, although they should appear as complex, living beings. She suggests a compromise approach, in which the agent is thought of as a mechanism which can take advantage of the human propensity to create narrative explanation to create the appearance of living action.

Narrative is many, not one

NI is radically interdisciplinary, drawing on narrative concepts from many humanistic fields of study. Narrative is not a single entity or a single, tightly related set of concepts. As the term is used in humanistic discourse, narrative can mean many things. Narrative can mean a tightly woven story communicated by a strong authorial voice to an audience. Narrative can mean the internal imposition of coherence by which a person makes sense of her life, or the communally constructed group memory by means of which a group organizes past experience. In the broadest sense, narrative can mean an entire worldview (as in "grand" or "master" narrative). And within each of these gross distinctions, there lie yet more distinctions. For example, within the notion of narrative as a tightly woven, author-given story, there lie distinctions such as literary, cinematic and dramatic stories, each of which has its own set of properties and corresponding inspirations and design implications for NI researchers. Thus narrative is a family resemblance concept, a cover term for a rich set of ideas.

The richness of narrative presents some interesting challenges for the emerging field of NI. One challenge is to maintain open lines of communication; with so many different inflections of the concept of narrative, workers will have to make an effort to be clear on the notion of narrative they are using and how it relates (or doesn't relate) to other notions of narrative.

Anoter challenge will be to remain true to the richness of narrative. AI, like the rest of computer science, tends to prefer general and abstract formulations. Applied to narrative, this will result in the attempt to assimilate all narrative phenomena to a single, simplified formulation. In order to build systems, abstraction and simplification are necessary tools. The danger lies in forgetting

for what purpose a simplification was made or parhaps that a simplification has even occurred. With a concept as complex and evocative as narrative, there will be particulaly strong pressure to side simplification. If this were to happen, the original richness of narrative, an endless source of inspiration and delight, would be lost.

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