Narrative for Artifacts: Transcending Context and Self

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Abstract

We discuss the importance of narrative intelligence (story-awareness, story-telling, historical grounding) in regard to an agent’s transcendence of its immediate local temporal context to create a broad temporal horizon in which the experience and future of the agent can be accounted for, together with the advantage that narrative provides to sociality by making the experience of others available without the risk of having to undergo the experience for one’s self. Concepts and consequences for the design of artifacts are surveyed, together with a brief description of a formal algebraic framework affording support for narrative grounding.

What’s a Story For?

We address what it is about narrative that makes it worthwhile for natural and artificial agents. Interest in narrative in literature, cultural studies, psychology and the arts is of course much older than in Artificial Intelligence (AI) - in some cases ancient - and has necessarily focused primarily on human notions of experience and communication, and on human methods of structuring narrative flow in discourse, or other media such as film and books. This primarily natural human-based, or anthropocentric, viewpoint on narrative has now been extended metaphorically in various ways to agents.

The current widespread interest in narrativity and narrative intelligence in artificial intelligence (e.g. (Schank 1990)), in the design of artificial agents (e.g. (Sengers 1998; Elliott et al. 1998)), and as an important dimension in the consideration of system design (e.g. (Don 1990)) is a reflection of the importance of temporal structure and history in the experience of human agents in terms of dealing with the world. Such temporal structure has been or can be applied in allowing agents to take advantage of mechanisms used in natural historically grounded systems, and for making systems friendly to beings such as humans who possess narrative intelligence or expect it in artificial agents. Narrative aspects have been key in applications for both interfaces (e.g. (Don 1990)) and entertainment (e.g. (Lester & Stone 1997)), among many other areas, but have even been used in such applications as support for system development in software engineering, e.g. in scenario generation for requirements validation (Minocha et al. 1997; Maiden et al. 1998).

The topic of this paper, and related work of the author (among others), is to identify and formalize a notion of narrative for biological systems, agents and artifacts that may serve to clear the air to some degree on what is key in narrativity. By identifying what appear to be crucial features of narrative phenomena, this is intended to provide a useful framework for researchers and artifact designers in which to consider narrative. Some key concepts identified are rigorous notions of meaning and information for agents and observers. In contrast to most formal approaches, the approach here is centered on the structural coupling of agents with their environments, and the interaction dynamics between agents (whether biological, hardware, or software). Analyses along the lines of theoretical framework described here may be useful in the construction of narrative agents and artifacts, in the study of human and other animal narrative systems, as well as in related areas such as the study of imitation (Nehaniv & Dautenhahn 1998b) and emotion (Elliott et al. 1998; Rolls 1999; Nehaniv 1998; 1999 submitted).

Extrasensory Channels

A feature of narrative, but not necessarily of all forms of communication, is that narrative provides an ‘extrasensory’ channel by which an agent may obtain meaningful information (see below) to modulate or guide its immediate or future behavior. Related means in which this may occur include memory and remembering (often also involving narrative structure), and, with generally smaller temporal scope, emotions.

Temporal Horizons: Scope and Transcendence

Heidegger (Heidegger 1972) saw the state of man as being as situated in the Now, being there in the imminence of the Future in relation to the impinging Past. This ‘temporal horizon’ is extremely broad in humans,
apparently greatly so compared to other animals. The
great temporal scope is evidenced by such of our emo-
tions as hope and regret, our concern with planning for
future actions and story-telling about past or imagined

Wittgenstein (Wittgenstein 1968) gave the famous,
and supposedly absurd, example of a dog who expects
his master to return the day after tomorrow. The per-
ceived absurdity of this example is based on our (proba-
ably correct) attribution of much smaller scope to a dog’s
ability to envision temporal structure: although we can
accept that that the dog might indeed expect his mas-
ter’s return “any time now”, “soon”, and perhaps even
“tomorrow when the sun comes up again”, the longer
period in Wittgenstein’s example implied to be within
the scope of the dog’s capacity for comprehension seems
excessive, although we have no proof of this.

The vast temporal horizon of humans means that
humans will tend to deal with interaction in a way
that makes narrative sense, and may anthropomorphi-
cally expect their technological agents to do so. Af-
fact and narrativity thus intertwine with each other and
are relevant to issues of human-tool interaction and rela-
tions over time as well as to human-human interac-
tion whether face-to-face or via networked media. But
such ‘extrasensory’ data from narrative may help art-
tificial agents to escape from the present and a rigid
perception-action cycle as well.

Three Areas for Historical Grounding
The areas of temporal grounding for artifacts, in the
interaction of humans and their tools can be divided
into three areas:
(a) recognition of narrative structure: recognizing that
others (humans, animals, agents) have a past history
and using this in manner that allows present behaviour
to be understood and future behaviour to be predicted
to some extent. Relevant terms are story-awareness and
biographical reconstruction. Related terms are: projec-
tion of experience, ‘hearing a story’, detectingintention
movements, attributing a history, learning from experi-
ence of others, literature.
(b) expressing narrative structure: the communication
of meaningful information regarding past or possible fu-
ture events, i.e. events removed from the Now. Relevant
terms are story-telling, narration, explaining context,
describing motivations and plans, teaching, communi-
cation.
(c) having a narrative structure: the dependence and
reliance of the agent on temporal dynamics in in-
teracting with its world Relevant terms are remem-
bering, scheduling, planning, autobiography, autobi-
ographic agent, historical grounding. Peripheral terms
are intention, drives, emotions, moods, recording, state,
development, trace, learning, growth.
The terms autobiographic agent and biographic re-
construction were introduced by (Dautenhahn 1996), with
formal development in (Nehaniv 1997; Nehaniv & Daut-

Narrative and Design
Current software and agent technology has barely
touched these three areas, but we believe they will be
essential in freeing agents from social as well as tempo-
ral isolation. Moreover, in interaction with humans or
in mediating human-human interaction over networked
media, it is desirable to take into account that humans
are temporally grounded, narratively intelligent beings.
Their evolutionary heritage leads them to expect that
the actions of others are embedded in a context of past
history and future events. Software and robotic agents
that do not respect the narrative grounding of humans
may seem bizarre to them, may disappoint them, or
may lead to cognitive calluses in human users that re-
result in psychological and interpersonal changes in the
course of long term interaction with technology as adap-
tations to it. Without support for narrative intelligence,
such technology often fails to support human wholeness
and does not optimize the human-tool relationship (Ne-
haniv 1999a). Together with affective issues, narrative
and story-telling offer an important rich, undiscovered
country loaded with opportunities and dangers for the
designers of technology.

Streams of Meaning
The elementary nature of considerations here and be-
low is intended to highlight important features of nar-
rative, from a philosophical and cybernetic viewpoint,
as a basis for rigorous study. In this exposition, we
avoid a mathematical formulation, and proceed in a
largely ‘pre-formal’ manner, that should also serve as
preparation and motivation for rigorous case studies ap-
plying the mathematical framework of (Nehaniv 1997;
Nehaniv & Dautenhahn 1998c; Nehaniv 1999b) to the
illumination of narrative and interaction for artifacts.

We introduce below a notion of meaning for agents,
which will be a pre-requisite for the notion of [mean-
ingful] narrative.

Reactivity: Sensors and Actuators
Consider an agent from a first-person viewpoint, the ex-
perience of stimuli, especially through sensors, senses,
and interaction with the environment via actuation,
action and interaction in its situated (or embodied\(^1\)).
Events (including passage of time) trigger changes of
its internal state.

Affect: Loosening the Grip of the Now
If the triggering stimuli are primary or secondary rein-
forcers in the sense of animal learning (i.e. stimuli which
the agent will work either to obtain or avoid, either by
its nature (primary) or after learning (secondary)), then
the change of state is called by neurophysiologists an
‘emotion’ (e.g. (Rolls 1999)), and this state may mod-
ulate further behaviour. Similar to emotions, but of
\(^1\)See (Quick et al. 1999) for the sense of ‘embodied’ and
its degrees in both physical and non-physical settings.
longer term are ‘moods’, whereas ‘drives’ are analogs of emotion that result from internal state, perhaps in interaction with environment stimuli, to bring homeostatic parameters into preferred ranges. ‘Taxis’ and ‘tropism’ are names for reactive versions of such state changes connected directly with inflexible behaviours. The level of taxis or tropism is close to much of the basic level in behavioral robotics as developed in the school of Rodney Brooks.

The cost and reward of experience stimuli provide a single dimension (a kind of ‘common currency’ (Rolls 1999)) along which to evaluate the result or desirability of action, and the relative values of these costs and rewards (or ‘pains’ and ‘pleasures’) may be modulated by the current state of the agent. Most attempts to introduce ‘emotion-parameters’ into AI systems, can be seen as an attempt to solve the well-known contextualization problem of AI and robotics, for instance, to transcend simple reactivity by allowing the settings of the parameters to modulate behaviour, so as to respond appropriately to the given context or to provide a basis for learning (See (Nehaniv 1999 submitted)).

**Meaningful Information**

Information in the channels of sensing and actuating for an agent, including interaction channels that affect its state, as well a channel related to the general passage of time (which may be different in biological and artificial agents, indeed possibly cyclical, discrete, or continuous, and need not be correlated with time for other agents) are referred to as meaningful (Nehaniv 1999c; 1999b) for the agent. A channel may also be meaningful for an observer who attributes such changes to the agent, whether consciously or not (Nehaniv 1999c; 1999b).

**Formal Narratives for the Self and Others**

Sequences events may also be recorded in ad hoc, haphazard and opportunistic ways in real biological systems. This may range from state change in response to a history of stimulation, to neural changes, learning, development, and growth. They may be of small or large temporal scope.

Records of sequences of events and/or of their resulting state changes, encoded in systematic ways, are called formal stories or narratives. For a given agent or observer, they comprise an algebraic structure called a ‘historical expansion’ in the the algebraic theory of abstract automata and semigroups (Nehaniv 1997; Nehaniv & Dautenhahn 1998c; 1998a). An element of such an expansion over a meaningful channel (in the sense of the preceding section) is then a meaningful narrative. Note that the qualifier ‘meaningful’ only makes sense in relation to the particular agent or observer involved in ‘witnessing’ the channel (see above). There may be several such agents and observers in any particular case.

A narrative in this formal sense simply consists of a systematic record of events and resulting state transitions for the particular agent. This record need not be an exhaustive specification, but may focus in a systematic [functorial] way on particular aspects of the events. In this way, the narrative is a historical record of experience either of an agent itself or attributed to one by an observer – of course, the narrative could possibly be an invented one rather than a result of actual experience.

**Transcendence of the Present and Self**

Such narratives may serve as a basis for memory, and in this case they may be considered stories about the self. Transmission, by whatever means, of such a formal narrative to another agent may be meaningful for the second agent. This implies that the state of the second agent can be affected by receiving the narrative. If the receiving agent has a similar enough body-environment coupling and the means to ‘decode’ or interpret the narrative, there is a possibility that the narrative could be useful to it. That is, the narrative could serve as something meaningful (in the sense above) to the recipient. Some ways in which this happens in real life, is that the agent is able to learn from the stories, or experience, of the first agent.

Both the cases of narrative for the self or for another provide possible streams of meaning for agents other than direct sensory ones, and moreover, the changes induced by ‘hearing’ a story need not be ‘emotional’ but may nevertheless serve to modulate behaviour. Yet they break the reliance of an animal or machine-learning agent on a need to experience the consequences (e.g. costs and rewards) of its own actions directly, either by making use of past experience of the self (remembering a story) or of another (narrativity). In this way, narrative can be viewed as at least as fundamental to intelligent behaviour, at least in humans (and possibly bonobos and dolphins?), as are emotion and affective response in the modulation of behavior in other animals and agents in escaping from mere reactivity.

From this perspective, narrative is another means not only to approach solution of the contextualization problem, but to transcend the first-person in learning by making use of the experience of another, a second-person (Nehaniv 1997; 1998; 1999c; 1999 submitted). The use of narrative in grounding intelligence is in this sense a second-person technique for building ‘intelligent’ artifacts grounded in a social world as well as by their structural coupling to the environment. Indeed, it has been argued that the nature of reality itself as experienced by humans and human cultures is an emergent effect of narrative interactions (Bruner 1991). (Such emergence of a shared reality is of course not arbitrary but must be grounded in the particular embodiments and interactions of the agents.) This may well also prove the case for important applications of artificial agents that interact with humans and with each other, and the formal methods overviewed here should provide at least one inroad.
References


