

Research Article

Story and Recall in First-Person Shooters

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Story has traditionally been seen as something separate to gameplay—frequently relegated to an afterthought or epiphenomenon. Nevertheless, in the FPS genre there has been something of a renaissance in the notion of the story-driven title. Partially, this is due to advances in technology enabling a greater capacity for distributed storytelling and a better integration of story and gameplay. However, what has been underrecognised is the dynamic, epistemological, and psychological impact of story and story elements upon player behaviour. It is argued here that there is evidence that story may have a direct influence upon cognitive operations. Specifically, evidence is presented that it appears to demonstrate that games with highly visible, detailed stories may assist players in recalling and ordering their experiences. If story does, indeed, have a more direct influence, then it is clearly a more powerful and immediate tool in game design than either simply reward system or golden thread.

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1. INTRODUCTION

In our recent paper [1], we discussed a simple study designed to offer evidence of one of the ways in which nonludically significant devices within an FPS game have a direct impact upon how the experience of the game is recalled and reported. Subjects played one of two games with very different levels of visibility and importance of story and then undertook a semistructured interview based around four major aspects: plot, character, avatar, and world. The research focus was whether subjects appeared to utilise story as a framework for their recall.

Narrative and games have a rather turbulent historical relationship, particularly in academic circles, but it is not our intention to add to volume of writing on this subject here. Thus, rather than entering into a debate about the relative narrativity of games, we will concern ourselves with the functional operation of story in FPS systems and, in particular, how they might relate to memory.

Firstly, we will offer an alternate way of conceptualising story information in games that coopts both Barthes' atomisation of narrative [2] and Carr's appropriation of the protonarrative [3]. Secondly, we will briefly introduce the notion of narrative psychology and the claims that there exist innate story-like structures in cognition that would predispose subjects towards the favoring of story-like

sequences, the interpretation of sequences as stories, or better recall of sequences with highly apparent story-like structures.

2. STORY IN GAMES AS PROTONARRATIVE NETWORK

Barthes argues for four fundamental units that act as the building blocks of all narrative [2, pages 79–124]. These units are divided into functions, which relay action, and indices which relate to abstract, atmospheric, or psychological notions. For example, the unit “He wrote” would be classed as a function as it conveys an irreducible action, whereas “He was tense” falls into the category of indices. Both categories may be further defined: functions according to their relative importance and impact, and indices according to their level of abstraction or specificity.

Barthes classes functions as either cardinal, which are both consecutive and consequential, or catalyst, which are only consecutive. In other words, cardinal functions are critical to narrative progression, whereas catalysts may be crucial to the telling of the story but their omission will not affect the basic structure of the story itself. True indices refer to “the character of a narrative agent” [2, page 96] such as an emotion, mood, or atmosphere, whilst the other subclasses, informants, locate within the temporal environment of the narrative. Barthes argues that everything within a narrative is essentially constructed from these four classes of objects.

In itself, this taxonomy is important because it enables a structural, rather than semantic, classification to occur when approaching narratives, asking questions such as whether there is a dearth of catalyst functions (suggesting a lean, reportage style of text), or large numbers of informants present (perhaps prompting a higher level of trust in the reliability of the narrative).

The idea of functional units is extremely powerful because they operate far below the threshold of a fully formed narrative situation that has been so problematically applied to games. Conceptually, it is not difficult to conceive of a situation whereby as Jenkins notes “Narrative can also enter games on the level of localized incident, or what I am calling micronarratives” [4, page 125]. However, his conceptualization of micronarrative is problematic as it just seems to lower the threshold beyond which a sequence can be defined as a narrative, which rather misses the point of the ludologists’ issues with their structure rather than their scale [5, 6]. More useful is Carr’s notion of protonarratives.

Carr also notes that narratives are composed of isolatable units that, whilst not containing explicit causal sequences, have a form of interpretative predisposition hardwired into them [3]. In other words, we can understand a network of units that, when perceived, is likely to lend themselves to one particular interpretation over another. Bartlett famously conducted a study, whereby native American myths with nonwestern narrative structures were converted in memory by Western subjects to yield more conformist and recognisable Western narratives [7, pages 64–94]. Between the preexisting interpretative structures of the subject and a network of protonarrative units that predisposes a particular interpretative outcome, a story is formed. Thus, for the remainder of this paper, when we speak of stories, it is the protonarrative network with its predetermined relationships we are referring to.

This conceptualization of story neatly sidesteps the narrativity debate by not requiring games themselves to be narrative objects, but simply to contain a set of objects at least some of which have predetermined semantic as well as ludic relationships. Protonarrative networks may contain sequences, but it is just as likely that the collocation of their constituent elements will be enough to trigger a particular interpretation by the player. There are very clear links here to schema theory.

3. SCHEMA, STORY, AND GAMES

Schema theory essentially posits a set of inbuilt and learned mental architectures that hold generalised situational knowledge. Schank and Abelson’s contextual dependency theory [8] is schematic at root such as Minsky’s frames: “a data-structure for representing a stereotyped situation” [9, page 1]. The basic notion of schema is that once enough cues have been received to trigger the schematic response; the following operations are essentially put through this filter.

Thus, not only may we infer a story schema from Bartlett’s study, but we can also propose schema for media experience and gaming. Indeed, Ijsselsteijn (2003) argues

that learned schemata are fundamental factors in users’ experiences of media:

From the anecdotal evidence accumulating throughout media history, it becomes clear that people’s responses to media are not a linear product of the extent of sensory information that the medium provides but are very much shaped by people’s previous experience with and expectations towards media. It would seem a little odd to us now if people should panic and run out of a movie theatre at the sight of an approaching train on the screen. This is because our *media schemata*, or knowledge representations of what media are, and are capable of, tell us what to expect from mediated experiences, including the perceptual tricks that cinema or VR can play on us. (2003:37).

When schemata are triggered, they adjust the interpretation of further signals, making other schemata more or less likely to fire in turn: priming occurs. For example, closure is generally agreed to be a fundamental, even unavoidable aspect of narrative, to the extent that Kermode wonders, “Why does it require a more strenuous effort to believe that a narrative lacks coherence than to believe that somehow, if one could only find it, it doesn’t?” [10, page 53]. Thus, when the schema for story fires, we could postulate that it increases the expectations of closure and following the type of interpretive activity that may occur. Equally, once a situation crosses the threshold to be identified as a first-person shooter, the shooter schema fires and predisposes a certain type of perceptual activity and action. In a pilot study, Pinchbeck et al. [11] noted that experienced FPS players tended to centralize their gaze and use the mouse to visually explore the environment, whereas inexperienced players tended to keep the mouse static and allow their gaze to move around the screen. A possible explanation of this disparity in visual behaviour is that experienced players know that shots, when they need to be fired, will hit whatever is central on the screen. Thus, it is advantageous to synchronise the acts of visual exploration and aiming.

Schemata offer a model by which a network of units would trigger a particular interpretative frame. In other words, all a game needs to do is to contain a suitable network of protonarrative objects, and a player will tend towards a story-like interpretation of their play. This offers a functional bridge between Juul’s “real rules and fictional worlds” [12, page 163]. A story interpretation, therefore, becomes, as Rein and Schon describe “one of a class of *framing* procedures, that is, strategies for organising and deriving solutions for problems” [13], or “an organising principle for human action.” [14]. In other words, a protonarrative network which triggers a story schema to fire as the primary interpretative device may help players to understand what occurs during the game session. It should also be noted that there is no contradiction or complication arising from both story and shooter schema firing simultaneously. The experience of playing, *Bioshock* (2007) or *S.T.A.L.K.E.R.* (2007) games which invests so much, so clearly, in their stories, is clear evidence of this.

This paper is primarily concerned with the simple question of whether a strong story helps players remember more of their gameplay experience and in better detail. This

begs the question of why we might expect this to be the case, and that requires us to consider the relationship between memory and story in a little more detail.

4. STORIES AND MEMORY

In his classic study, Tulving proposed a distinction between two forms of memory:

“Episodic memory receives and stores information about temporally dated episodes or events, and temporal-spatial relations among these events. A perceptual event—is always stored in terms of its autobiographical reference to the already existing contents of the episodic memory store. Semantic memory is the memory necessary for the use of language. It is a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations.” [15, pages 385–387].

Eysenck and Keane [16, page 165] note that there has been some controversies whether this distinction actually obfuscates a unitary process, but it is the natural fusion of episodic memory and schema that are of interest here. In particular, the autobiographical and temporal aspects of episodic memory have very clear conceptual relationships to the notion of story schema and, indeed, narrative psychology has made much of this.

Conceptually, there is only a short step to be made from an autobiographical memory, where a sense of coherent self relative to a sequence of events is held by an organism, to the idea that our inner experience is a form of story in itself—though at this point we will revert to the term narrative in keeping with the literature and to avoid confusion with our ludically orientated definition of story used elsewhere. Robinson and Hawpe make this point, for example, “Experience does not automatically assume narrative form. Rather, it is in reflecting on experience that we construct stories” [13, page 111]. This would seem to suggest that whilst episodic memory in itself needs not be explicitly narrative, any reflection upon it is. Further, Crossley argues that by planning our lives and ourselves, we engage in a filtering process, thus, creating an ongoing narrative from the nonlinear, frequently noncausal complexity of life [17]. Equally, our own actions and responses, including memories, are filtered and represented to form the self.

Indeed, the self may be seen as the result, illusory or not, of predictable responses to environmental situations. In other words, a sense of coherence in response suggests a coherent, locatable self at the centre of a complex and shifting world. Thus, the inward projection of a self as distinct from the environment, tied up in the process of distal attribution, or reality inferral [18], requires a temporal sequence of coherence in order to logically maintain itself. In other words, without a sense that the self that is being postulated existed prior to the current experience, and without the sense

that past and current experiences fall along a single trajectory of ongoing experience, the construct cannot be maintained.

The autobiographical function of episodic memory may, then, not simply be to enable the storage, recovery, and implementation of representations of prior events and body states, but also to enable the illusion of a singular, unitary self to exist in the first place. Just as the psychological processes surrounding presence, vection, and so forth, all enable the organism to separate itself from the environmental field, so episodic memory anchors it to its own developmental past. If the formation of causal sequences in relation to a stable perspective is fundamental to the sense of self, then, narrative is given a very core position in our subjective being indeed. Bruner, for example, argues for a “protolinguistic readiness for narrative organisation and discourse” [19, page 80], whilst Nath [20] contends that narrative is a critical component of assembling a subjective stance and thus crucial to any experience. Underlying these claims is, however, a rather weak and inclusive definition of narrative, more an “assimilating structure” [21, page 91] than a represented causal sequence. We are reminded of Juul’s point that in the narrative/ludology debate, the narrativists were characterised by a very inclusive definition of narratives, whereas the ludologists demanded a much less inclusive one [12, pages 156–159].

Once again, schema theory offers a middle ground. We do appear to be, at least given the evidence of their ubiquity, story-telling animals as Schank has argued [22]. Stories are common and powerful schema, and what can be taken from the more extreme narrative psychology positions is that there is a conceptual and structural closeness between schema and narratives that may explain why this is the case. In terms of games, the tendency for us to tell stories may lead us to two hypotheses:

- (i) That player will tend to format their gameplay experiences as stories, even when story is not a dominant feature of gameplay. This is analogous to Bartlett’s subjects framing the contents of “The War of the Ghosts” to fit their most comfortable means of recall;
- (ii) That where the protonarrative units within a game (world, characters, and avatar) can most easily be formed into a network, or where a stronger set of predetermined relationships (the plot) exists, players will find it easier to remember details about these units which are not directly related to gameplay. In other words, by formatting the play experience as a story, nonludically significant detail will be more easily and effectively recalled.

5. THE STUDY

This is all very well in principle and theory, but what empirical evidence can be offered to support it, and how does it relate to the practical business of game development? The following section is a summary of the paper original published at *Cyber games 2007*, and the reader is referred to this paper for a full analysis of results [1].

A simple study was carried out, whereby twenty-six participants played either Bethsheda's Call of Cthulhu: Dark Corners of the Earth (2006), or id's Doom3: Resurrection of Evil (2005) for 40 minutes in more-or-less natural playing conditions and then undertook a semistructured interview. In this interview, subjects were asked to discuss four factors in their experiences: the world they explored, the characters they met, the avatar they controlled, and the sequence of events—literally “what happened when you played the game?” There were two data sets under investigation. Firstly, the quantity and quality of information about the gameplay experience reported; and secondly, whether there was apparent use of clear story structuring in the reports obtained. Thus, the study aimed to determine whether there was any evidence that a game with a strong and complex story such as Cthulhu (CTH) aided recall or prompted recall with a story-like structure, and whether either of these factors were present or diminished in the relatively unnarrative resurrection of evil (RES). Readers are referred to the original paper for a discussion of the in-game narratives and gameplay of these titles. The key factors of the results are, however, reproduced below.

5.1. Character

CTH subjects demonstrated a generally good grasp of the large cast in the opening levels of the game. When asked “Can you tell me about some of the characters you met in the game?”, most subjects responded by talking about classes of characters. Individuals were mentioned less and, interestingly, the most frequently mentioned individuals were not actually met in the game but integrated within goal structure. However, it was intriguing to note that 5 subjects included the avatar in their choices of reported characters.

By contrast, there are only two named NPCs in RES, one (George) is met briefly during the first level and the other (McNeil) being visually introduced in the opening cutscene and represented by occasional radio contact. Alongside, there is an unnamed marine who bequeaths his weapon and immediately dies and various unnamed and doomed voices that occasionally come through over the radio. The opening cutscene shows the player's squad being killed prior to play starting. What is interesting is that given the paucity of NPCs in the game; one might expect the NPCs to stand out; however, only 5 of the 13 players remembered McNeil; none remembered her name correctly. Less than half (5/13) reported George and only one guessed at his name. Half the subjects spoke of the other marines and team mates, suggesting that they “could speak to you,” or “they were helping you.” Of these, only one noted that the entire squad was wiped out prior to play starting, though it is possible that they attributed the unnamed grabber gun marine to this squad. The CTH subjects were altogether more successful at recalling names. Only 5/13 could not recall a single name from the game, and two of these later remembered.

All subjects from both groups had no problem when asked to provide a motive for one of the characters they had identified. In the CTH group, these were usually fairly accurate, and in many cases picked up on subtle nonludically

significant information. Player's asked about the motive for the marines being on Mars in RES which were far less sure and in some cases highly creative in their responses. 9/13 players were asked and the results varied from the semiaccurate “there was an incident,” “they used to go there and lost the colony” to the false “they have discovered this archeological site,” “conducting some research,” and fanciful “human curiosity.” Only one subject noted the cover story given in the opening sequence.

5.2. Environment

Subjects were asked to talk about the environments they visited and then prompted with two further questions: any particularly memorable features or details, and what sounds were present? CTH splits into two levels: the opening sequence in a dilapidated cult mansion and its underground tunnels and Innsmouth itself. RES is all set in an archeological dig site, with alien architecture slowly transforming into the human base sited above it. These were variously described as caverns, mines, high-tech industrial, and Aztec. The presence of technology was noted, often (4/13) in relation to the number of boxes and crates lying around. What was most striking about RES subjects descriptions of the environment was how directly indexed to gameplay mechanisms many of them were. 6 of the 13 subjects talked explicitly about generic game devices rather than the presented environment.

The darkness of the levels was the consistent feature noted, with all subjects referencing it. Beyond that, features were evenly distributed between pits, doors, and interactive objects (a power cell transplant sequence was noted by 4 subjects). It was quickly recognised by 5 subjects that each hostile agent was preceded by a signature sound; aside from this, ambient noise was noted. However, no subject reported the radio transmissions that sporadically interrupt the action, nor the direct instructions from McNeil.

The CTH group found it easier to talk about the environments, perhaps due to the diversity of spaces they encountered. 12/13 subjects differentiated between the two playable levels. Two subjects confused the cult house with the asylum in the opening cutscene, which may be attributable to the morgue and experiment rooms in the basement. A further 7/13 used distinct narrative structuring when describing the environments. 4 of the 13 subjects referred to a gameplay mechanism: the save point, the fact that the designers increased tension by reducing the sizes of the environments at critical moments, the reduction of the visual field with movie bars to indicate a cutscene, and the lack of weapons increasing a sense of vulnerability. Finally, 4/13 subjects reported the town's name unprompted (two were correct), which may be interpreted as evidence as it was engaged with on a homodiegetic level rather than just as a game map. It is also worth noting that two subjects questioned the reality of the Innsmouth level altogether, both suggesting that the entire episode was actually a hallucination and that the player had never recovered from the six-year psychotic break that separates the levels. Again,

this may be taken as evidence that they were engaging with the environment at a significantly narrativised level.

5.3. Avatar

One thing both study groups shared was a very distinct conceptual distance between player and avatar. Only two subjects in the entire study referred to the action in the first person. Further, the majority used the second when discussing plot, character, and environment: “you go into the basement,” “you are this marine.”

However, it is important to note that over identification with the avatar can be problematic, as it exposes the limitations of the game system [23]. The fact that most of the subjects in the study felt that they were controlling Jack or the marine, or in some cases “aiding” them, acting as a team suggests that the avatars were functioning effectively.

Subjects were first asked about their relationships to the avatar, and then whether they thought he had a definable character. If the answer was yes, they were prompted to try and encapsulate this personality in few words. Finally, they were asked about their motives and whether they considered this to be the same as their avatars.

All but one of the CTH subjects easily identified with Jack, citing the amount of background material as the major reason they were able to do so (4/13 also stated that the gameplay device of hearing his heartbeat increase in times of stress helped draw them in). Although they clearly distinguished themselves from him, 6/13 said they felt they were looking through his eyes, or otherwise, operating in tandem with the character. One suggested he felt as if he was playing part of Jack’s mind, with the game script providing the counterpoint. All the subjects said they could identify a clear character, and their suggestions of personality fitted those suggested by the game, with stating that the amnesia, whilst giving him a motive to continue playing, was a block to this. The one subject who failed to identify with Jack said that whilst the amnesia gave him a motive to continue playing, it blocked his empathising with the character. Four also inferred personality from his responses to the game’s action: “he asks a lot of questions,” “he is very curious,” “he is not afraid of finding things out,” and seamlessly integrating essential gameplay devices with the presented world. Most felt that their motives and Jack’s coincided—a drive to find things out, to solve the mystery of not just Innsmouth, but the missing six years of his life.

RES subjects found empathy easy too but struggled more with the notion of character. Although 8/13 felt that the marine had a character, when asked to summarise his personality, there were noticeable pauses; then 5/13 constructed a personality based around their play styles—either “cool, level headed, not freaked out by what is happening” or “a kick-ass marine.” The remaining four described the avatar as bland, or a shell, though two of these suggested that as the story progressed, they may understand more about him. One tied his motive to try to find his squad, which is completely missing from the actual game; another candidly pointed out that the initiation of the action comes from the avatar picking up the artifact and that he was playing the “idiot who caused

it all.” Noticeably, the RES players were more likely (5/13) to differentiate their motive from the avatars: whilst he was variously “trying to get to the surface,” “escaping,” “staying alive,” “returning the artifact for study,” they remained only superficially involved, wanting to explore the game, or just responding to wave after wave of hostile avatar. Several (3/13) wanted additional characterisation to flesh out the marine’s character.

5.4. Plot

The need for closure was highly evident in both subject groups; most of whom assumed a closed narrative was unfolding, even if they did not fully grasp it. CTH subjects generally coped well with a highly complex narrative, including an unconventional temporal sequence. One subject failed to identify Jack in the opening sequence; another suggested that the suicide was successful and the Innsmouth level was not real. All of the CTH subjects described the plot fully or near fully and did so using clear storytelling structures: there was clear cause and effect and understanding of temporal sequencing. More to the point, every subject thought a story was operating behind the action—two even suggested that it was more important than the action (one describing the experience as more like watching a film than playing a game) and were happy to ascribe the gaps in the information they were given to a plot arc they had yet to uncover although most assumed they would uncover it. Asked if they believed that other characters within the game knew more than they did, all but one answered yes. Certainly, Cthulhu is a mystery game and is quite deliberately aimed at creating this impression. None of the subjects found the action arbitrary—they all assumed that it was only their ignorance of the final plot resolution that hindered their understanding. Conspiracy, and its counterpart, amnesia, is a powerful theme in FPS games, occurring in nearly every title, and it is evident why this should be. Not only does it allow narrative development to be offered as a reward scheme, but it also achieves two more direct gameplay functions. Firstly, it lowers the player/avatar’s status, training them to be reliant upon the system for information, which is why it is so often attached to high-status NPCs. Secondly, it allows the system to gain control over information shortfalls: it is simply not necessary to offer a complete package of information if the closure is operating successfully—the player will contribute at least the assumption that all will become clear and, as such, shortfalls and contradictions can be masked.

Tellingly, even though RES subjects struggled to create a full narrative of their experiences, quickly degenerating into brief summaries “monsters come and you shoot them,” “you just keep going until to find the boss,” and several 3/13 admitted complete ignore as to what was going on; most (7/13) believed there to be a story happening. This would seem to confirm that Kermodé’s question remains valid in the sphere of game research. Only two drew attention to the PDAs lying around the environment which provided background story. One was convinced that McNeil would be revealed to be the nemesis figure (another essential FPS device). Two subjects noted that the “leaders” (presumably McNeil),

rather than being in possession of extra information, had no idea what was happening or what to do about it; three others correctly recalled her statement that “I have seen this before.” Narrative plays a very small part in Resurrection of Evil’s action, and there is little in the way of a coherent ecology: demons teleport in according to shock value and challenge, and it is not altogether surprising that 4/13 subjects found the action arbitrary.

6. CONCLUSION

A game with a high emphasis on story such as Cthulhu seems to enable players to recall a substantial quantity of the information it presents, even when this is presented in a nonstandard and incomplete fashion. Although players often fail to remember names, they are adept at either recalling or inferring motive. Even though Cthulhu contains a much higher number of characters than Resurrection of Evil, subjects were able to remember much more about them, suggesting that players of the latter were simply not paying any attention to them. This may sound banal, but it is evidence that the system is training the player to attach significance. Further, the fact that players of Resurrection found it difficult to recall their actions in detail suggests that a strong plot may not only act as a reward scheme but aid in orientation and postexperience affect.

Players in both titles inferred personality from cutscenes and homodiegetic information where this was lacking; they frequently constructed it themselves from the activities of the avatar. The environments and objects of Resurrection without a strong plot structure were recalled often according to gameplay devices, whereas Cthulhu’s were placed in a homodiegetic context. Finally, closure was clearly operating across both games, even with a rudimentary narrative; Resurrection players inferred a body of unknown information that many were convinced would be revealed to them, even when they misread the plot—and often remembered little of the primer from the opening cutscene.

Thus, rather than a late bolt-on, in reality no less simplistic, or the alternate reward system, we need to consider story within games as an integrated aspect of the overall system. If utilising narrative devices such as character, plot, closure, and voice has a direct and dynamic impact upon the psychological processes in operation during the act of play. Then, not only does this provide us with a less subjective means of interpreting story in games, but it begins to open up a pseudo-mechanistic approach to putting together effective, ludically functional stories. In order to achieve this, we have proposed that the common issues of narrative can be bypassed if we utilise the concept of protonarratives to envisage story as a network of objects, with a degree of predetermination in terms of relationships which tend to yield interpretation within a predetermined range.

In a very real sense, this invites us to, one way or another, avoid the “art” of stories in favor of the “craft.” In analysing story in games in this way, the mechanics of the application of story to game design can be exposed, making the highly complex field of narratology and its application to psychology accessible to those whose specialisms lie in

other areas of game design and development. Further, it highlights the direct impact story can have upon gameplay, in terms of creating more memorable, complex and affective gaming experiences. We are in the position, in terms of the maturation of the both game design and game research, for the medium to demand a wholly distinct and specific understanding of the nature and use of story as a functional technology.

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Special Issue on Artificial Intelligence in Neuroscience and Systems Biology: Lessons Learnt, Open Problems, and the Road Ahead

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Since its conception in the mid 1950s, artificial intelligence with its great ambition to understand intelligence, its origin and creation, in natural and artificial environments alike, has been a truly multidisciplinary field that reaches out and is inspired by a great diversity of other fields in perpetual motion. Rapid advances in research and technology in various fields have created environments into which artificial intelligence could embed itself naturally and comfortably. Neuroscience with its desire to understand nervous systems of biological organisms and system biology with its longing to comprehend, holistically, the multitude of complex interactions in biological systems are two such fields. They target ideals artificial intelligence has dreamt about for a long time including the computer simulation of an entire biological brain or the creation of new life forms from manipulations on cellular and genetic information in the laboratory.

The scope for artificial intelligence, neuroscience, and systems biology is extremely wide. The motivation of this special issue is to create a bird-eye view on areas and challenges where these fields overlap in their defining ambitions and where these fields may benefit from a synergetic mutual exchange of ideas. The rationale behind this special issue is that a multidisciplinary approach in modern artificial intelligence, neuroscience, and systems biology is essential and that progress in these fields requires a multitude of views and contributions from a wide spectrum of contributors. This special issue, therefore, aims to create a centre of gravity pulling together researchers and industry practitioners from a variety of areas and backgrounds to share results of current research and development and to discuss existing and emerging theoretical and applied problems in artificial intelligence, neuroscience, and systems biology transporting them beyond the event horizon of their individual domains.

Before submission authors should carefully read over the journal's Author Guidelines, which are located at <http://www.hindawi.com/journals/aai/guidelines.html>. Prospective authors should submit an electronic copy of their complete manuscript through the journal Manuscript Tracking Sys-

tem at <http://mts.hindawi.com/> according to the following timetable:

Manuscript Due	September 1, 2009
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Publication Date	December 1, 2009

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Special Issue on Fuzzy Logic Techniques for Clean Environment

Call for Papers

The fuzzy technique for clean energy, solar and wind energy, is the most readily available source of energy, and one of the important sources of the renewable energy, because it is nonpolluting and, therefore, helps in lessening the greenhouse effect. The benefits arising from the utilization of solar and wind energy systems can be categorized into two sections: energy saving and the decrease of environmental pollution. The clean energy saving benefits come from the reduction in electricity consumption and from using any conventional energy supplier, which can avoid the expenditure of fuel supply. The other main benefit of the renewable energy is the decrease of environmental pollution, which can be achieved by the reduction of emissions due to the usage of electricity and conventional power stations. Electricity production using solar and wind energy is of the main research areas at present in the field of renewable energies, the significant price fluctuations are seen for the fossil fuel in one hand, and the trend toward privatization that dominates the power markets these days in the other hand, will drive the demand for solar technologies in the near term. The process of solar distillation is used worldwide for arid communities that do not have access to potable water. Also some solar technologies provide other benefits beside power generation, that is, fresh water (using desalination techniques).

The main focus of this special issue will be on the applications of fuzzy techniques for clean energy. We are particularly interested in manuscripts that report the fuzzy techniques applications of clean energy (solar, wind, desalination, etc.). Potential topics include, but are not limited to:

- Solar power station
- Wind power
- Photovoltaic and renewable energy engineering
- Renewable energy commercialization
- Solar cities
- Solar powered desalination unit
- Solar power
- Solar power plants
- Solar systems (company)
- World solar challenge

- Seawater desalination to produce fresh water
- Desalination for long-term water security

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Special Issue on Machine Learning Paradigms for Modeling Spatial and Temporal Information in Multimedia Data Mining

Call for Papers

Multimedia data mining and knowledge discovery is a fast emerging interdisciplinary applied research area. There is tremendous potential for effective use of multimedia data mining (MDM) through *intelligent* analysis. Diverse application areas are increasingly relying on multimedia understanding systems. Advances in multimedia understanding are related directly to advances in signal processing, computer vision, machine learning, pattern recognition, multimedia databases, and smart sensors.

The main mission of this special issue is to identify state-of-the-art machine learning paradigms that are particularly powerful and effective for modeling and combining temporal and spatial media cues such as audio, visual, and face information and for accomplishing tasks of multimedia data mining and knowledge discovery. These models should be able to bridge the gap between low-level audiovisual features which require signal processing and high-level semantics. Original contributions, not currently under review or accepted by another journal, are solicited in relevant areas including (but not limited to) the following:

- Multiresolution-based video mining and features extraction
- Dimension reduction and unsupervised data clustering for multimedia content analysis tasks
- Mining methods and algorithms (classification, regression, clustering, probabilistic modelling), as well as association analysis
- Machine learning paradigms that perform spatial and temporal data mining
- Machine learning paradigms that allow for an effective learning of hidden patterns
- Object recognition and tracking using machine learning algorithms
- Interactive data exploration and machine learning discovery
- Mining of structured, textual, multimedia, spatiotemporal, and web data
- Application of MDM to contents-based image/video retrieval and medical data

Before submission authors should carefully read over the journal's Author Guidelines, which are located at <http://www.hindawi.com/journals/aai/guidelines.html>. Prospective authors should submit an electronic copy of their complete manuscript through the journal Manuscript Tracking System at <http://mts.hindawi.com/> according to the following timetable:

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