

Master's Thesis in Informatics: Games Engineering

# Information Flow in Distributed Multi-Agent Systems as a Game Mechanic for Immersive Story Worlds

**Jakob Raith**



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## Informationsfluss in verteilten Multiagentensystemen als Spielmechanik für immersive Geschichtswelten

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I confirm that this master's thesis is my own work and I have documented all sources and material used.

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JAKOB RAITH



# Abstract

[18]





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# 1 Introduction

Narrative heavy video games are ever more asked for by players. This is indicated by a report from WePC.com in which 73.55% of people who play video games prefer single-player games over multi-player games [26]. This is, however, not to say that multi-player games can not focus on story. It is common though for single-player games to have a stronger focus on narrative. WePC.com further notes that gamers claim to play more video games because of the COVID-19 pandemic. Between March 23 and June 3rd 2020, the number of players has increased by 46% in the United States, 41% in France, 28% in the United Kingdom and 23% in Germany. [26]

The rise in interest in single-player games is also backed by Sony Interactive Entertainment. With 46% of the console market, Sony is the leader of a \$58.6 billion industry segment. [5] A supposedly leaked document mentioned in a Vice.com article reports, that the Sony consoles internal tracking tools found that PlayStation users spend more time offline than online on a regular basis [15]. Finally, in an interview from March 2020, the head of PlayStation's Worldwide Studios, Hermen Hulst says that Sony is "very committed to quality exclusives. And to strong narrative-driven, single-player games." [24] PlayStation Studios consists of 14 individual studios that focus on narrative driven single-player games [17]. All these commitments of the console industry leader to storytelling is a clear indicator, that the demand for games with narrative focus is present in the video game landscape.

Modern narrative games feature stories that rival movies in terms of production value. In May 2018, Eidos Montreal boss David Anfossi said, that the game *Shadow of the Tomb Raider* [12] cost \$75 - \$100 million just for production [7]. These more expensive games feature usually a very cinematic and action oriented storyline with well-known voice and performance actors. They are also usually quite linear in their structure and storytelling. Developers want to ensure that players actually see and experience the expensive set-pieces in the stories which explains this more linear approach to storytelling.

But would interactive media like video games not profit from the potential of actually interactive storytelling? Players often wish for games to give them a lot of options in their interactions. "I want to be able to do whatever I want" is a request that comes up frequently when talking about open world games. Acclaimed game designer Sid Meier in his 2012 talk at the Game Developer Conference describes games as a "series of interesting decisions". He explains that through limiting and carefully crafting the actions a player can take, the gameplay becomes more compelling. [7]. So the argument can be made that "being able to do whatever I want" could actually be detrimental to the game experience. This argument can be extended into the story. Authored stories often follow rules of their respective culture's storytelling traditions. We perceive stories that deal with culturally relatable topics and follow familiar structural rules, more favorably. [3]

But would players be able to make interesting narrative decisions naturally, given the option by a game that does not restrict interactions to an authored story? Does a video game story require an author at all? Can we develop systems that take on that role? Could a game mechanic provide all necessary elements to satisfy narrative requirements? This thesis aims to explore not only what those requirements are and how they contribute to

game stories, but also introduces a framework for game mechanics that allow the utilization of world state information for narrative purposes.

A story can be abstracted as numerous pieces of world information that are exposed to the person experiencing the story, in this case the player. If we have story that goes like "The knight slays the dragon." We now that the world consists of a knight, a dragon and the act of slaying the former. These pieces of information about the actors and acts in the world are then framed into a narrative structure - the story.

In this thesis, I developed a game mechanic based on modeling this kind of information into objects that exist in the game world. They are created by interacting with the world and are perceivable by agents that exist in the system next to the player. By allowing the non-player agents to react to newly learned information, the model creates an interplay among all agents in the system. The resulting game mechanic then is based on retrieving relevant information about characters or other objects in the game world and introducing new information as the player. This could even be used to create factually wrong information and thus allow the concept of lying to agents.

Elevating the exchange of information in multi-agent systems to a core game mechanic, and allowing players to exploit the information flow is a novel system, that not many games support today. It is also, a step towards creating actual interactive story, because it allows for truly influencing the game world but still enabling developers to define rules for how agents and the environment reacts and thus enforcing a narrative structure.

## 2 Theory

This chapter presents the various fields of study, that were encountered or utilized while developing the game mechanic and its implementing prototype game. This includes fundamental story, game and quest theory, information theory, multi-agent systems, consensus protocols, emotion engines and inference engines.

### 2.1 What is a story?

There exist a multitude of definition on what a story is. Rayfield argues that story is a narrative item that exists throughout all cultures. He concludes that there exist a universal concept of a certain structure that listeners will recognize as a story. He limits this structure by degree of complexity and argues that listeners will only recognize the structure as story within certain minimal and maximal bounds of complexity. These bounds would then be the same across all cultures. [20] Scheub takes another approach and sees story more as "a means whereby people come to terms with their lives, their past; it is a way of understanding their relationship within the context of their traditions. It is a means of accessing and valuing history: in the end story *is* history." [23] Lastly the Oxford Dictionary of Literary Terms more formally describes story as a set of events that are selected and arranged in a specific order and told by a narrator. The specific order of the events is called the plot. [1] One thing that most definitions have in common however is that stories are an important tool for humans. Stories help us to interpret and process information and experiences. They enrich subjectively perceived facts and form them into each person's individual truth. This is the "*meaning*" of a story. This "meaning-making" is also part of the psychological process in self-identification and the creation of memories [8]. Stories are furthermore an important factor in human communication, used as parables and examples to illustrate points. Storytelling was one of the earliest forms of entertainment.

When looking into definitions of what a story *is*, the matter quite quickly goes into the area of what a story *does*. I already mentioned how it is a vital tool for the human psyche but there are some more concrete functions that stories fulfill.

#### 2.1.1 Functions of Storytelling

The motifs and contents of stories and the modes of narration are highly culturally individual aspects. The functions these elements serve though, can be found across all cultures. One example is to make one narration more understandable by putting it into relation with another story. This is commonly referred to as a metaphor. Now these relational stories don't have to be imaginary per se. They can be a retelling of events that have actually transpired and help underline the point of the narrator. On the far hand of abstracting stories to make a point is the very careful use of words to find an objective true transpiring of events. This is what happens in courtrooms. It is a retelling of events,

but the order and selection is so careful, so meticulous, that an actual fair "true" story might be revealed. [21]

As mentioned above stories and storytelling are used to share and interpret experiences. The human brain is evolutionary predisposed to process, store and recall memories in the form of stories [14]. Humans think in narrative structures and mostly remember facts in the form of a story. Facts are smaller versions linked to a larger story, which supports analytical thinking. [2] This makes storytelling such a great tool for teaching as well. There is research about how storytelling is a meaningful teaching method that can be applied in education to encourage the development of caring, empathy, compassion and to develop a deeper cultural understanding. [4] It is not event solely the listening person who is learning from a story. Often the discovery of a personal meaning of a story is only made visible when telling a story. Thus also the storyteller can learn something new. [6] This is applied in therapeutic storytelling, where through retelling experiences in story form, the storyteller attempts to better understand their own thoughts and situation. This can be supported by questions from a therapist who carefully steers the storyteller through their narration to pinpoint insights. [16]

There are countless situations where we encounter storytelling precisely because we want to share experiences and emotions. Stories are used to inspire and motivate, to manage conflicts, for marketing or for political practice [13]. These are all situations where the intent is separate from the story itself. Where we turn to storytelling because the human brain can process them so effectively. Another aspect is however when we tell stories for the story's sake.

### 2.1.2 The Appeal of Stories

I have now established that there is a difference between the intention of storytelling itself and utilizing it for another purpose. The difference is that we do not enter a courtroom to tell or listen to a story. We do so to find the truth. The past has simply show us that the careful recounting of events combined with precise inquiry, has proven a good way to do so. So when we do not tell stories as a means of achieving another intention, we also share them just because they are stories. For this we can take on both positions, that of the narrator or the listener. Again, a multitude of situations presents itself for these applications. We listen to bedtime stories that our elders tell us. We tell a funny anecdote to our friends on a night out. Humans have created whole industries around the consumption of stories. We read books to immerse ourselves into stories, we watch movies or shows and we play narrative video games. The fact that so much of our time is willfully spent listening to, watching or interacting with stories, must mean that there is something worthwhile there. The mere consumption of a narration seems to be satisfying in itself.

When we hear stories, the brain releases the hormone Oxytocin. This hormone heightens feelings of trust, empathy and compassion. It positively influences social behavior and helps us to feel more connected to others. [10] Humans are inherently social beings. We want to connect to others around us. We try to create situations and use known cultural signals to connect on a non-verbal level. Humans mimic body language, laugh more in social situation than alone or use physical contact to communicate. [9]

When we hear a story, the brain is enabled to form connections to the people who listen to the story with us, to the narrator and to the characters in the story. Communication is a shared activity resulting in a transfer of information across brains. Research shows that during successful communication, the brains of both the speaker and the listener shows



common, temporally linked, response activities. When we hear a story, our brain mirrors activities in the sensory center of the storyteller. [25] This attempt to sync brain activity is a deeply social connection. It also means, that when we hear an enjoyable story, the brain behaves as if we would experience it ourselves.

### 2.1.3 Stories in Media

The consumption of stories has led to the creation of huge industries that focus entirely on creating and delivering stories to customers around the world through different kinds of media. That term comes from the Latin word *medium* for "middle" which again stems from the ancient Greek word *mésos* for "the middle" or "the public". Today we use the term media as word for "the means of communication". [11] In the context of storytelling this could be oral through a present storyteller, audio through a audiobook, visual through a book or e-book, audiovisual through theater plays, movies or series or interactive through games and other interactive media. Oftentimes, when we talk about "the media" today, we refer to an industrialized consumption of content or news.

The economic factor of these storytelling media cannot be underestimated. The global Entertainment & Media Outlook analysis from PriceWaterhouseCoopers reports over US\$ 40bn for global box office revenue in cinemas for 2019. Cinema revenue of course took a nosedive because of the COVID-19 pandemic in 2020 and 2021 but are expected to recover and grow by 2023. Video games however have been steadily growing to roughly US\$ 62bn for traditional games revenue and almost US\$ 92bn for social or casual gaming revenue in 2021. These numbers are also expected to grow in the coming years. [19]

Storytelling of course works differently and has different requirements in each of these mediums. Books for example allow for a seamless switch of inward and outward perspective of characters or thought processes. Movies as an audiovisual medium, are more restricted to an outward perspective and have to use different storytelling techniques to transport the inner feelings of characters. There is also a structural difference to all these forms of media since there are conventions for runtimes for movies or an episode of a show. [22]

**2.1.4 Expectation & Feedback****2.1.5 The optimal Experience****2.1.6 Quests****2.2 Concretizing Information****2.3 Game Mechanics****2.4 Multi-Agent Systems****2.5 Consensus****2.6 A Heuristic for Information****2.7 Related Work****2.7.1 Emotion Engines****2.8 Inference engines**

## 3 Implementation



## 4 Results



## 5 Discussion





## 6 Conclusion



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