Towards an analytical framework for AI-powered creative support systems in interactive digital narratives

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Abstract

Interactive Digital Narratives (IDNs) is an interdisciplinary research area related mainly to Narrative Studies, Design, Human-Computer Interaction, and Gaming. In this field, empirical investigations on using Artificial Intelligence (AI) support systems for creating IDNs are growing, demonstrating the value of exploring their potential. However, a systematic categorization of AI support system features and key elements is missing. This paper addresses this gap by presenting an analytical framework to describe and map such systems. The analytical framework is the result of multimethod qualitative approach, that combines mainly case study analysis with interviews. A total of 60 empirical investigations retrieved through academic and grey literature have been collected and analyzed, enabling to identify: AI support systems' types (*AI-based Creative Support Tools*, *AI Authoring Systems*, and *AI Support Systems for Interactive Digital Narratives*) and categories (*AI system structure, Creativity, Interaction,* and *Narratives*). A cross-case analysis of seven selected exemplary cases of the type *AI Support Systems for Interactive Digital Narratives* reveals needs, challenges, and research opportunities to fulfil. The main contribution of the framework for researchers, practitioners, and designers is its use as an analytical and generative tool to acknowledge existing and future AI support systems for creating IDNs.

Keywords: AI Support Systems; Analytical Framework; Co-Creativity; Human-AI Collaboration.

Introduction

Transformation is about change. Digital transformation can be strictly related to the discourse of *Transition Design* (Tonkinwise, 2019; Escobar, 2018), which stimulates designers to embrace the change of design paradigms that will lead to radical positive social and environmental change (Davis et al., 1993). *Transition Design* proposes new approaches to design and problem-solving techniques based on a deep understanding of the dynamics of change within complex systems so that designers can act as agents for change (Escobar, 2018; Irwin, 2015). According to Irwin, transitional design proposes that more compelling future-oriented visions are needed to inform and inspire designs in the present (Irwin, 2015). Design tools, systems and methods can aid in developing these visions. Designers deal with processes, systems, and projects; they need ideas to propose creative solutions to given problems. This paper is based on the doctoral research on *Human-AI co-creativity* by the first author. The PhD thesis investigated the relationship between designer and ai systems in the field of interactive digital narrative, contributing to a nuanced understanding of the subject matter under investigation (Serbanescu, 2024).

An IDN is construed as an interactive narrative artefact specifically crafted for engagement by the end-user called *interactor* (Murray, 2011), for whom it is meticulously designed to elicit interaction and through this interaction gain insights in complex issues. The authoring of an *Interactive Digital Narrative* (IDN) can be considered a design process, as it is a creative process considering goals and constraints that result in a product, the narrative engine, which addresses aesthetic, functional, economic, or socio-political considerations that help the audience to get a better understanding of complex issues (Dorst & Dijkhuis, 1995). Authoring as a process can be brief or lengthy and complicated, involving considerable research, negotiation, reflection, modelling, interactive adjustment and

re-design. It is based on good conceptual models, which require good communication. As the process of authoring entails inherent complexity, the utilization of artificial support systems emerges as a viable strategy to streamline and enhance the efforts of authors in realizing their goals in the design of an IDN.

In this contribution, the author of the IDN product identifies himself/herself with the figure of the designer, the one who creates the IDN system in cooperation with an AI for a given type of interactor. The designer and AI system are considered here as complementary partners who collaborate in the creative design process of the IDN artefact. Therefore, the authoring process is considered part of the creative design process. The collaborative partnership between the designer and the AI system underscores the imperative for the designer to cultivate a nuanced understanding of the AI system, thereby establishing the foundations of a co-creative relationship.

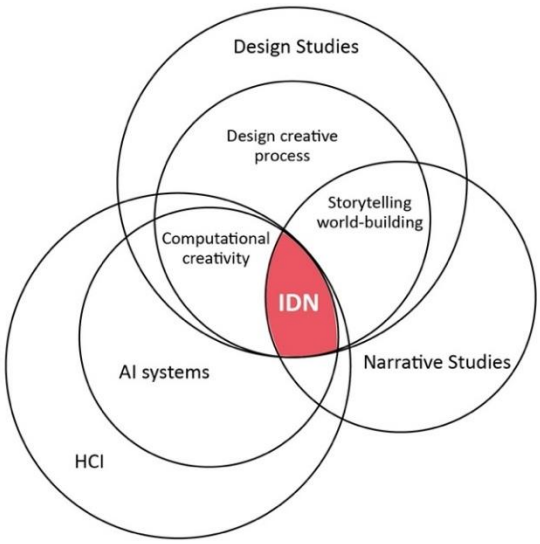
We look at the design process through an AI lens, where the AI acts as a complex support tool for creating IDNs in the form of interactive narrative co-creativity experiences. Many AI support systems help in creative design processes, such as *AI-based Creative Support Tools* (CST) capable of enhancing the creative process and *AI Authoring Systems* that help build stories. Examples of co-creativity experiences between AI and human designers can be found in systems for the design of stories and narrative worlds (Sineglossa, 2019; 0/0/0000 0:00:00 AM, storyboards (Bernal et al., 2019a), interactive stories on social platforms (Yanardag et al., 2021), or art installations that tell a story (Benediktsson, 2019).

The investigation presented in this study approaches the problem from a transitional design perspective and explores the role of AI in the designing of IDNs. In the present investigation, we introduce an analytical framework to provide the requisite information to enable the comprehension and mapping of AI systems. The objective is to facilitate the designer's comprehension and navigation of AI systems, thereby aiding in the development of IDN artefacts. Furthermore, we illustrate the practical application of this framework by examining case studies, thereby demonstrating its efficacy in realistic scenarios. The paper aims to understand better what type of artificial help in a system can be utilized to facilitate IDN designers in achieving their vision of building appropriate narrative environments that enable interactors to comprehend complex issues.

2. The Interdisciplinary Field of IDN and AI Support Systems

IDN as a domain is interdisciplinary, being situated between scientific and humanistic domains (Snow, 2012). From the point of view of tools, processes, and methods, it addresses three main disciplines relevant to this work: Design studies, Narrative studies, and Human-computer interaction (HCI) (Figure 1).

Figure 1: IDN research field map.



Source: (Serbanescu, 2024).

In *The living handbook of narratology,* narrativity is defined by Abbott (2011) as an adaptable term to the context of use, having intrinsic conflicts based on the role it assumes. This makes IDN a cover term for a rich set of ideas that also incorporate the process of interactive storytelling. In fact, according to Mateas and Sengers (1998), a narrative is not a single entity nor a single set of concepts; it is interdisciplinary, drawing on narrative concepts from humanistic perspectives. From an authoring point of view, IDNs questions the limits of what can be considered storytelling (Sethi, 2021), as IDNs challenge the author's and the reader's conventional role. For instance, a digital interactive storytelling system such as *Shelley* (Yanardag et al., 2021) is an AI system that creates stories but does so through interaction with the online community. At the same time, author and reader can converge in the same person; this can happen when the reader is considered the one who interprets the text, giving it meaning, becoming the author of a text written by someone else (Heath, 1977; Iser, 1972). *Shelly* can be considered a system that generates individualized narratives that humans and computers co-author. It is not our intention to focus on the dualism problem of authorship between reader and author since, in this contribution, AI systems and designers share authorship to some extent. Designers are planners who use stories to convey a message or obtain useful information during the creative design process for given purposes. Still, the example of *Shelley* serves to clarify that IDN, through its interactive component, involves multiple agents in creating stories, and new technologies can support this process. Interaction is a crucial component that can be a participatory process consisting of an interactor's engagement with a computer program to produce an output (Koenitz, 2010). From an interaction perspective, since the early 1990ties, it was also the narrative approach that turned HCI from engineering to design (Mateas & Sengers, 1998). Narratives are not reduced to the construction of stories but also include the way stories are told. They extend beyond mere story construction and encompass how stories are conveyed. Narratives are considered a broader concept of the IDN product; their meaning cannot be pinned down into a single definition. As articulated by Chatman in his seminal work *Story and discourse: narrative structure in fiction and film* (Chatman, 1980), narration comprises a narrative's substantive components and the narrative discourse, with diverse structural configurations (such as flashback, flashforward, and in medias res) and disseminated through different media (such as television, books, theater, and social media).

As a research area and practice, IDN experiences have an academic discontinuity (Crawford, 2013). According to Koenitz, there is an incomplete and sometimes confused body of knowledge and for this reason, there is an urgent need for systematization of the area through guidelines and taxonomies, adopted, and further developed (Crawford, 2013; Koenitz, 2018). When the topic of AI systems is introduced within the IDN context, scholars tend to refer to those AI systems designed to generate stories as procedural sequences of text and not as IND experiences since the developments of these systems are limited to story generation (Gervás et al., 2006; Roth & Koenitz, 2017; Szilas, 2015). *AI Authoring Systems* risk not being considered a support and creation tool for IDNs because most of their application and use is text grammar-based models of stories (Gervás et al., 2006) and revolves around automated story writing.

Hence, AI-driven authoring support systems should interface with the human agent who actively dialogues with the system. This interactive exchange of information serves a dual purpose: facilitating the learning process for the AI system and enabling the human agent to process data from an alternative perspective. This dialogue can turn into a collaboration, a perpetual interaction between two agents to improve one another. Collaboration is the key to supporting the very complementarity of the two agents. The AI system is mainly a helpful support tool because it is capable of processing and analyzing a large amount of data in a short time compared to humans, which do not achieve the same performance in speed and accuracy (Kasparov, 2017; Lovelock, 2019). AI automates learning processes starting from data, applying logic thinking, which humans prefer to replace with intuition by making assumptions instead of calculating every possible decision and outcome (Jarrahi, 2018). The support given by the AI system is often automation of the narrative authoring process, and the system takes over some tasks to be carried out that facilitate the process. For example, there are generative algorithms that create a story model starting from a dataset of stories (Li et al., 2012), that suggest through words or phrases the continuation of a story (*Metaphor Magnet*, 2019; Yanardag et al., 2021), or that automate the actions and events of the characters based on the designer's choices that influence the outcome of the story (Cavazza et al., 2002;

Mateas & Stern, 2002). In this way, there is not necessarily space and support for creativity, just for the automatization of the story writing process. However, it is, in particular, this aspect of analytical strength that can help in identifying interactor's patterns that can help creative work. The other category is that of AI systems that support creativity and is used within creative design processes (Jeon et al., 2021), which can result in the creation of music or songs (Carney et al., 2021; Huang et al., 2020), a sketch or coloring of a drawing (Kim et al., 2022; Bernal et al., 2019a), or 3D virtual spaces (Urban Davis et al., 2021). Creativity is here understood as *Human-AI co-creativity*, which distinguishes between *P-creativity* and *H-creativity*, taking Boden's definitions as reference (Boden, 1994). *P-creativity* refers to personal creativity concerning new findings, concepts, and ideas that a person has not been aware of before, which can bring value and novel to the individual who identifies an idea not previously considered. This knowledge is limited to the person's interests and limited in time. *H-creativity* refers to *Historic* creativity related to findings unpublished in the history of humanity. Therefore, AI support systems are considered creative if they result in a creative idea concerning the person with whom the system collaborates or with respect to the whole of humanity in the history of humankind. Clearly, in the case of *human-AI co-creativity*, P and H creativity refers to human and non-human agents and can be detected through analytical means in a corpus of individual or domain works (Serbanescu & Nack, 2023). Creativity brings with it a cultural tradition in which the anthropocentric vision is the dominant one, i.e. creativity can be considered as such only if the human being is its creator. On the other hand, if creativity emerges as the result of human-AI collaboration, we more correctly need to call this *co-creativity*. In the literature, we speak of *Computational Creativity* (CC) as an automated version of human creativity (Gu & Amini Behbahani, 2021), in which the AI agent is autonomous in creating ideas, which can be more or less valid.

On the other hand, AI lacks emotional characteristics, especially empathy (Lovelock, 2019). Sometimes not having to deal with emotions could be successful, for instance, in determining the result of a chess game (Kasparov, 2017), but feeling emotions such as fear, love, or loss, is necessary to establish narratives that are meaningful for humans. Both human and non-human agents are different but complementary. The strengths of one compensate for the weaknesses of the other, and the key to success stands in collaboration to reach common goals by combining the brute force of analyzing the data from AI with the intuitive capabilities of humans in problem-solving (Jarrahi, 2018). To date, IDNs have not explored their full potential through AI systems, though examples of AI-generated narratives are presented in section 4.

3. The Methodological Overview

The approach followed in the presented work is what Krogh defines as *drifting by intention* (Krogh & Koskinen, 2020). The practice of drifting is seen positively in Design as a discipline. It demonstrates how the design researcher learns and reshapes knowledge concerning their findings (Krogh & Koskinen, 2020). The conducted study classifies the observable AI support systems through a deductive approach that starts from the theory and goes on through empirical observations to validate the initial hypothesis of AI systems capable of supporting designers in the co-creation of IDNs. This contribution, therefore, presents *multimethod qualitative research* (Mik-Meyer, 2020) on the influence of AI support on IDN artefact creation based on a synthesis of Design studies, Narrative studies, and HCI. The investigation is conducted through a case study analysis that explores the topic of *human-AI system co-creativity* in and for IDN through several case studies of AI systems that support humans in creating IDNs. The case studies are exploratory, starting from a large body of system descriptive work of AI support systems (Koenitz, 2014), with little theory about them. The mapping of the case studies and their analysis is conducted to search for the support of or actual creative activity in those AI systems capable of creating INDs. The outcome of the case study is a framework that should help designers understand and apply AI systems into their design of IDN artefact that can address the needs skilled IDN designers use for creating IDN systems. Subsequently, an evaluative process is conducted on the analytical framework, involving interviews with academic experts drawn from the three distinct domains constituting the IDN discipline.

3.1. Case Study Method

The case study research was conducted on *Google Scholar*[1], the *ACM Digital Library*[2], and the *Scopus*[3] library. The sampling selection criteria consider only human-AI collaboration systems from the Design field and the IDN field created between 2000 and 2022, including models, prototypes, concepts, frameworks, and ready-made products. The original search started with the inclusive terms like *human-AI collaboration in Design* and *human-AI collaboration in IDN* and then refined them based on the findings. At first, 60 case studies were identified, and from those two categories of interest for designers emerged among the AI support systems:

- AI systems that support the creative design process, also called *Intelligent Creative Support Tools* (CST) (Main & Grierson M., 2020) or *AI-based CST* (Jeon et al., 2021).
- AI systems that support IDN creation are called *AI Authoring Systems* (Shibolet et al., 2018).

The collected case studies were then categorized and ordered according to these two categories. The 60 case studies are presented in a summary table (Table 1), showing that some case studies represent both *AI-based CST* and *AI Authoring Systems* categories. The case studies characterized by both categories constitute a third of all cases, which results from the observation of the case study categorization. This contribution shed light on a new category we define here as *AI Co-creativity Support Systems for IDNs.* That is, those AI systems that co-create with the designer in building IDNs, considering the definition of P and H creativity outlined earlier. The assumption is that this third hybrid category represents an emerging AI support system, despite being more complex to design and build, needs to be scholarly acknowledged to expand the research on that topic. Since the interest here is to find *AI Authoring Systems* that can support designers in the co-creativity process of IDNs, the seven case studies representing this third hybrid category (namely number 6, 30, 31, 43, 45, 51 and 52 in Table 1) are those picked for the analysis and comparison in Section 4.

Table 1: Case study evaluation.

#	Case Study	Year	AI-Based CST	AI Authoring Systems	#	Case Study	Year	AI-Based CST	AI Authoring Systems
1	A Graphical Platform for Building Storyworlds	2015		X	31	IAQOS - Roma	2019	X	X
2	Adobe Scene stich	2017	X		32	I-Storytelling	2002		X
3	Adobe Sensei	2017	X		33	InSight	2019	X	
4	Alan01 / AlanOnline	2009		X	34	IN-TALE	2006		X
5	AlterEgo	2019		X	35	ISRST-IS	2009		X
6	Ancona Centripeta	2019	X	X	36	Little Data Wranglers project	2017	X	
7	Angel_F	2006		X	37	Machine hallucination	2019		X
8	ArtBreeder	2018	X		38	Midjourney	2022	X	

[1] Google Scholar, for more info visit https://scholar.google.com (*Google scholar*, n.d.).
[2] ACM Digital Library, for more info visit https://dl.acm.org (*ACM Digital Library*, n.d.).
[3] Scopus, for more info, visit https://www.scopus.com/sources.uri?zone=TopNavBar&origin=searchauthorfreelookup (*Scopus*, n.d.).

9	BeeMe	2018		X	39	Mimesis	2003		X
10	Benjamin	2016		X	40	Minstrel remixed	2010		X
11	Calliope	2021	X		41	MuseNet	2019	X	
12	Colorbo	2022	X		42	NOLIST	2005		X
13	Creative Sketching Partner	2020	X		43	Omnia per Omnia	2018	X	X
14	Dall-E	2021	X		44	OPIATE system	2004		X
15	DeathKitchen	2006		X	45	Paper Dreams	2019	X	X
16	DED (Directed Emergent Drama)	2008		X	46	PASSAGE	2007		X
17	Deep dream generator	2015	X		47	PERSONAGE	2011		X
18	Deep — The Fabricant	2018	X		48	Scheherazade-IF	2012		X
19	Defacto	2005		X	49	Stereotrope Poetry Generation	2013		X
20	DINAH	2003		X	50	StoryLine	2017		X
21	D.O.U.G._2	2019	X		51	Shelley	2017	X	X
22	D.O.U.G._4	2020	X		52	TALEFORGE	2021	X	X
23	ENIGMA	2010		X	53	Teatrix	2000		X
24	Fabulist	2004		X	54	Tell a Story About Anything	2015		X
25	Façade	2002		X	55	The Virtual Storytellers	2003		X
26	FashionQ	2021	X		56	Thespian	2005		X
27	Flower	2020	X		57	The AniThings project	2017	X	
28	Human-AI co-creativity in songwriting	2020	X		58	Tone Transfer	2020	X	
29	Kuki (Mitsuku)	2013		X	59	Twine	2009		X
30	IAQOS — Bolzano	2020	X	X	60	U-Director	2006		X

Source: (Serbanescu, 2024).

4. The Case Study Analysis and Findings

In the initial stage of case study selection, which sought to identify distinctive features inherent to AI authoring tool systems fostering creativity, a decision was made to scrutinize seven chosen case studies through comparative analysis comprehensively. Subsequently, these case studies were systematically transformed into categorized and subcategorized units for analytical purposes, giving rise to an analytical framework. This framework elucidates recurrent and cross-cutting elements inherent in each case study, thereby facilitating their transformation into discernible categories and subcategories for systematic analysis. It is imperative to underscore that the exploratory nature of the case study analysis was undertaken with the overarching goal of

comprehending the operational dynamics of the support systems and the salient elements that constitute their foundation.

The summary and comparative sheet of the selected case studies are presented in Figure 2 (see the following page). The figure highlights the case studies which aim to understand how an AI system can support the user in creating IDNs and better understand the constitution of these systems. Seven case studies are compared, starting from considering the input/output categories that analyze the type of data entered about the narrative elements. The input/output ratio identifies the incoming and outgoing narrative elements, thus framing the purpose of the authoring system and the final artefact. The grey boxes represent the story, not just the single fragments of the story (actions, events) but their concatenations. The *Degrees of automation* of the narrative elements are an essential category that identifies the design of an AI system. The table includes the analysis of the type of AI system, its learning paradigm and the level of knowledge it can acquire. All these categories related to the AI system flow into a more qualitative and reflective category regarding the type of support the system can provide to the designer as the creator. That is how the AI system can be a resource for the designer and what are its characteristics, potentials and limitations. The *Type of AI system support* category is divided into:

1) The AI system is built to execute tasks. It cannot reason about the given input but provides automation for processing the data.

2) The AI system cannot reason about the given input, but has provided suggestions to address the input, which in some cases may inadvertently propose a creative output.

3) The AI system can reason on the given input, suggest creative outputs and carry out an ongoing collaboration with the designer as a creator.

Finally, an important category is the *Type of interaction* that influences the creative component triggered between designers and AI systems. Interaction as collaboration stimulates creativity, which in Figure 2 appears as an analysis category. Upon initial examination of Figure 2, it becomes evident that two out of seven case studies insert stories as inputs into the AI system, even if most of the analyzed systems have stories as output. The cases with the stories as output are used to insert fragments of texts, videos, photos, or pre-set commands. The most common type of AI analysis method is a neural network. It facilitates deep learning to identify connections among contents and layers. It can also handle more than one content modality, namely analyzing visuals (images or video) with computer vision techniques or text with NLP. The established output of those analysis methods can result in unexpected patterns and connections between contents, which can be surprising to the designer. Often this surprise effect results in the view that the system is creative, where it is mainly analytic. All the case studies are AI support systems, but most of the type of interaction is explicit, meaning that the designer can select pre-determined inputs and expect not a creative output, at least a creativity that is just computational. When there is a direct collaboration between the designer and the AI system, the system supports the designer in finding suggestions based on the ongoing designer's input and AI output. By triggering the designer to give a new input based on the previous system output and interact to find a creative idea for creating an IDN. Many AI systems support designers, but only at the executive level, to carry out tasks, not at the level of what can be considered a genuine collaboration that leads to problem-solving through creativity.

Figure 2: Case study map of comparison and analysis.

#	Case study	Year	Input					Output					Narrative																Elements of the AI system						ML paradigm			Degrees of knowledge										Type of AI support			Type of interaction			Creativity			
			Media type	Narrative elements				Media type	Narrative elements				Degrees of automation																Appli-cation		Methods							Reacti-ve AI		Limited memory AI																
				Story		Narrative world			Story		Narrative world		Story						Narrative world																																							
				action	event	character	ambient		action	event	character	ambient	manual	modification	template	constrained	automated	manual	modification	template	constrained	automated	Computer vision	NLP	Neural network	Distributed AI	Knowledge representation	Statistical learning	Supervised learning	Unsupervised learning	Reinforcement learning	No previous knowledge		One topic		Differen topics same field		Differen topics different fields		1	2	3	No collaboration	Indirect collaboration		Direct collaboration	No creativity	Computational creativity		Human-AI co-creativity	
																																				C	S	C	S	C	S	C	S	C	S					implicit	explicit					P	H
1	Shelley	2017	text (tweets)	x	x	x	x	text (tweets)	x	x	x	x				x								x	x					x									x	x									x				x	
2	Omnia per Omnia	2018	videos	x	x	x	x	movements	x	x	x	x					x					x	x			x	x		x	x								x	x									x				x	
3	IAQOS - Rome	2019	vocal messages, texts, pictures	x	x	x	x	interactive graph	x	x	x	x	x					x					x	x	x		x				x										x								x				x	
4	Paper Dreams	2019	drawings, text, audio	x	x	x	x	visual (storyboard)	x	x	x	x				x								x	x	x				x											x	x									x				x	
5	Ancona Centripeta	2020	text (info)	x	x	x	x	text (article)	x	x	x	x					x					x		x						x										x	x									x				x	
6	IAQOS - Bolzano	2021	text (data)	x	x		x	interactive graph	x	x	x	x	x					x						x	x		x				x	x										x	x									x				x	
7	Taleforge	2021	text and items	x	x	x	x	pictures	x	x	x	x				x				x			x	x						x											x	x									x				x	

Source: (Serbanescu, 2024).

4.1. Findings on Collaboration and Co-Creativity

Human-AI co-creativity is a collaborative relationship between humans and AI systems to support the creative design process. Co-creativity involves at least one human agent and one computer, considered a colleague, comparing its creativity to humans (Hoffmann, 2005). The type of interaction determines the degree of support for creativity or co-creativity when the AI system supports it and works with the designer as a creator to produce a creative idea. If the collaboration is direct, the outcome is more likely to be creative.

There is a slight difference between *computational creativity* (CC) and *human-AI co-creativity*. CC is an automated variant of human creativity (Gu & Amini Behbahani, 2021). Often AI systems are characterized by CC even if they are not designed to collaborate with humans. However, they can be *P-creative* for the designer when they suggest options that unintentionally become novel and innovative for the designer who did not have that in mind.

In *human-AI co-creativity*, the AI agent is more than a functional tool and acts as an autonomous creator that can give designers creative suggestions (Lopes et al., 2021). It is a tool for designers to collaboratively find novel ideas for stories (in content or structures) and, in this way, accelerates the storytelling process. In the comparison table presented in Figure 2, all the cases perform CC, except for cases one and two that facilitate human-AI co-creativity. Case number five, *Paper Dreams*[4] (Bernal et al., 2019a), is an example of CC. The system allows continuous dialogue with the designer about constructing a storyboard. In this case, the system supports the creation of the storyboard by suggesting sketches related to drawings or keywords entered the system through an interface. Creativity support is scarce, mainly because the AI system takes care of suggesting illustrations and sketches similar to those drawn by the designer, retrieving them from the AI system database. The AI then carries out a task assigned to it, and based on the designer's input, the system responds with a new suggestion from time to time.

[4] Read more about the Paper Dream project here https://arts.mit.edu/paper-dreams/ (Bernal, 2022).

Case number one, the *Shelley*[5] AI system (Yanardag et al., 2021), instead reacts to people's stories collaboratively, facilitating in this way human-AI co-creativity. The AI system proposes a story and publishes it on the dedicated X account (former Twitter), and the community suggests how the story continues. The AI then selects the scariest story and posts it on X as a follow-up. This is a good example of co-creativity since the system considers multiple parties collaborating in the creative process, sharing their ideas about the story and building a narrative together in an interactive manner.

In *Omnia per Omnia*[6] (Benediktsson, 2019), little robots with distributed AI help the artist reproduce the dynamic crowd flow from the city of New York on the canvas, working side by side with the artist. The result is a giant canvas that visually represents the dynamic crowd flow. Conceptually, it can be considered an interactive digital way to tell a story from New York from a spatial movement perspective. This project means creatively, something about the perception of daily spaces that, without the help of the AI system in processing all the video data of people walking on the streets, you could not have known. Except for *Omnia per Omnia* and *Shelley,* which work on human-AI co-creativity, the other cases deal with computational creativity in AI systems, which execute tasks that can help the designer build narratives, but not as a co-creative partner. At first glance, the seven selected case studies were considered part of the *AI-based CST* and *AI Authoring Systems*, as they support creativity and create IDNs. Still, this type of support does not translate for all cases into a relationship of co-creativity between designer and AI system, as represented by the *AI Co-creativity Support System for IDNs* category. In fact, by focusing on the categories of analysis and comparing the case studies (Figure 2), we realized that AI support systems are not clearly identifiable. The qualitative analysis implies structured reasoning to identify which systems can be recognised as CC or co-creative. The framework we introduce in section five (Figure 3) is a solution proposal that helps understand where to look and orient when dealing with *AI Co-creativity support systems for IDNs*.

4.2. Findings on the Narrative Elements

In this contribution, the construction of the narrative world (NW) is understood as the relational system of the characters that populate a digital and interactive environment through an AI system, where the NW establishes a relational system between characters-characters and environment-characters. The NW is, in fact, a container of potential narratives (Koenitz, 2015) triggered by the relationship between the various characters and the digital environment.

All seven case studies compared in Figure 2 are made up of a sort of NW, since the meaning assumed by the term does not respect the previous description. In our view, no selected case studies represent a narrative world. This awareness highlights, on the one hand, different interpretations of the same term and, on the other, a lack of investigation of the NW through AI support systems. In Figure 2, cases 3, 5 and 6 consider the NW as a space of stories. For instance, in *IAQOS Rome*[7] (Iaconesi & Persico, 2021), the AI system collects the stories of the inhabitants of the multicultural Torpignattara district of Rome. The NW, in this case, is a non-structured space that contains people's content about any topic, and the AI system finds correlations among them. Similarly, *Ancona Centripeta* (Sineglossa, 2019) collects all the stories from the citizens of Ancona concerning their city experience and their hopes and dreams about it. The AI system then provides futuristic output articles about Ancona 2030.

Case studies 1, 2, 4 and 7, consider the NW as an environment or a setting for actions performed by characters. In *TaleForge*[8] (Perez et al., 2021), for instance, the characters appear within a pre-established story, and the narrative world is considered a mere standing background. The same applies to *Paper Dreams* (Bernal et al.,

[5] Visit the following website to have more information about the AI system *Shelley* https://www.media.mit.edu/projects/shelley/overview/ (Yanardag et al., 2021).
[6] Visit here the website dedicated to *Omnia per Omnia* project https://sougwen.com/project/omniaperomnia (Benediktsson, 2019).
[7] Find more about the IAQOS project here https://iaqos.artisopensource.net (IAQOS, n.d.).
[8] TaleForge can be tested at the following link https://taleforge.streamlit.app/ (Perez et al., 2021).

2019a), where the NW is just a setting represented through a drawing scene in which characters are inserted. In *Omnia per Omnia* (Benediktsson, 2019), the robots are the AI support system that helps the designer as the creator to represent a narrative visually; they are not creating a NW as we intend.

4.3 Reflection on Findings

The chosen case studies for our comparative analysis should genuinely fit the hybrid category of *AI Authoring Systems* and *AI-based CSTs*, termed as *AI Co-creativity Systems for IDNs* in this study. Among the seven cases, only three show potential for establishing a co-creative relationship with interactors due to the original design focus on task automation rather than proactive collaboration. Evaluating creativity in human-AI collaboration presents challenges. For instance, *co-creativity* implies active AI participation in the creative process, collaborating with human creators. However, practical scenarios often involve passive AI roles, activated only upon interactor's request. Achieving true co-creativity proves challenging, especially in IDN contexts.

Another key finding underscores the inherent conflict between automation and co-creativity, revealing complexities in integrating *AI Authoring Systems* into creative processes. This calls for a deliberate approach to maximize narrative automation benefits while preserving human creativity integrity.

5. The Analytical Framework Proposal

The findings of the case study, in combination with the insights gained from the related work section, here in particular the work by Shibolet et al. (2018), this paper proposes a classification framework that allows designers to recognize and describe AI systems that collaborate creatively with humans in the creation of IDNs. The framework is outlined in Figure 3 and is a response and a proposal to understand and organize the body of knowledge related to AI support systems, which we assume will be increasingly present and prolific in the future developments of IDNs.

Two distinct categories of support emerged from the literature review that simultaneously accompanied the case study analysis: *AI-based CST* and *AI Authoring Systems*. The latter sees using an AI system that supports the author in creating IDNs. Still, this category of AI systems is part of the larger group called *Authoring Tools*, described by Shibolet as digital software capable of creating IDNs in the form of stories and/or storyworld (Shibolet et al., 2018). The support given by AI in authoring is often automation of the narrative authoring process, and the system takes over some tasks to be carried out that facilitate the process. We outlined earlier that in this way, there is no space and no support for creativity, just for the automatizations of the story writing process. It has also been shown that actual support of creativity requires an anthropocentric vision, i.e. creativity can be considered as such only if the human being is its creator. With the framework, we intend to show that creativity can also emerge as the result of human-AI collaboration, more correctly called co-creativity. In this context, Computational Creativity (CC) is seen as an automated version of human creativity, in which the AI agent is autonomous in creating ideas to support creativity and is used within creative design processes for designing music, drawings, or 3D virtual spaces. This type of creativity requires domain knowledge representations so that patterns can not only be recognised but also classified and interpreted. The framework's application area includes three types of AI support systems that emerged from the conducted case study analysis and literature review:

a) The *AI-based Creativity Support Tools* (CSTs) are AI systems that support creativity and can be used in the creative design process. The AI-based CSTs are mostly related to computational creativity, being generative AIs that mainly support humans in executing tasks rather than collaborating to solve problems (Jeon et al., 2021; Main & Grierson M., 2020). These AI systems generally involve designers in generative music, graphic, sketches, and image generation.

b) The *AI Authoring Systems* are those systems that generate co-authored narratives by humans and AI systems or AI algorithms that author their narratives (Shibolet et al., 2018).

c) The *AI Systems to Support Creativity in Building IDNs*, hybridizing the first two types of AI support systems above. This new category represents a new emerging typology of AI co-creativity support systems that involves the creation of IDNs thanks to a creative collaboration with the designer as a creator.

Figure 3: Visual representation of the analytical framework to categorize *AI Support Systems for IDNs*.

Source: (Serbanescu, 2024).

5.1. The Structure: Macro-Categories, Categories, and Sub-Categories

Building this framework is a work that resulted from reflective thinking mixed with findings from the literature review. Its construction originates and takes inspiration from the categories and descriptors in the structure classification table of Shibolet et al. (2018) authoring tools. It also follows the three research areas: HCI, Narrative Studies, and Design Studies, the equivalent of which has at least one corresponding representative category. To facilitate better integration of both approaches, a table with macro-categories has been created (grey color):

Identity kit, Project, Process, and *Other resources* (Figure 3). Categories and sub-categories characterize each macro-category.

5.2. Identity & Type

This macro-category is the framework's core and comprises four categories: AI system, Interaction, Creativity, and Narrative.

The AI system category is divided into five subcategories: *Application(s), Method(s), Machine Learning paradigms, Degrees of knowledge* and *Type of AI support.*

- Based on the system's complexity, the *Method* and *the Application* can be more than one and combined to perform different tasks. In defining those two categories, the study was carried out on schemes that cluster and position types of AI based on their function. Having found nothing authoritative in the literature, we decided to take them as a reference and combine categories that emerged from the index book *Artificial Intelligence — A Modern Approach* (Russell & Norvig, 2021) and the hierarchical system proposed by *ACM Computing Classification System* (*ACM Computing classification system*, 2012). This adaptation was made possible by the continuous comparison with the selected case studies, trying to choose categories to determine and describe existing items.

- The *Machine Learning paradigms* classification is also based on the book of Russell and Norvig (Russell & Norvig, 2021) and identifies supervised, unsupervised, and reinforcement learning.

- The *Degrees of knowledge* consider a limited level of knowledge of AI, or what AI has reached to date, which is beyond an understanding of a real awareness of content but more than a simulation of it (Searle, 1980). So, knowledge is divided between reactive AI, which has no memory and just responds to stimuli, and limited memory AI, a system capable of storing information and collecting it when needed (Joshi, 2022). Furthermore, knowledge is transversal concerning content and structure, where the content refers to the type of topic/s that the AI deals with, which may belong to the same or different areas. In the case of authoring systems, the story's subject may be based on one or different genres, but as the applied knowledge structure is of a taxonomy type, it might provide additional suggestions for genre extensions.

- Finally, the *Type of AI support* is inserted at the bottom of the AI system category since it results from reasoning that includes the items that precede it. This qualitative category serves to identify a type of practical support linked to problem-solving.

The *Interaction* category is built on the structure of the interaction mechanisms presented by Sauvé & Houben (Sauvé et al., 2022), which can be indirect or direct. In the case of the framework presented here, the type of interaction we are interested in analyzing is collaboration and based on this; the sub-categories vary slightly in meaning compared to the original setting.

The category relating to *Creativity*, representing the Design Studies side, is structured based on the findings from the literature review on creativity as a result of human collaboration with the AI system. Human-AI co-creativity is distinguished by *P-creativity* and *H-creativity*, taking Boden's definitions as a reference (Boden, 1994). The AI approaches covered here will be oriented towards pattern recognition concerning content and structure applied in the IDN design, where models are required that can memorize the individual IDN pattern of a creator as well as the pattern provided by the domain of accessible IDNs.

The Narrative category consists of *Narrative element*s and *Degrees of automation*.

- Concerning the representation of the narrative elements, the book *Il mondo narrative* (Pinardi & De Angelis, 2006) introduces a hierarchical classification of narrative elements adopted as descriptors in the analysis table. The *Narrative* is divided between the *Story* and the *Narrative world*; the latter element is essential and, at the same time, absent in relation to AI support systems, which deal with

the procedurality of the stories. This subdivision between story and NW for AI support systems is also applied in the *Degrees of narratives* sub-category that takes its structure inspiration from the work on the *Degrees of Automation of Plot and Space Generation* conducted by Kybartas and Bidarra (Kybartas & Bidarra, 2016), in which the NW is considered a mere scene setting.

The *Identity kit* macro-category is more articulated than other macro-categories since it is essential to identify the *Type of AI support*. This categorization manifests through three discernible functions: task execution, trends prediction and collaboration.

5.3. Project

This macro-category addresses the AI support system as a whole and is represented as a sort of personal data CV of the AI support system. The primary data (name, year, creator, ownership) and the objective are introduced. Moreover, there is the chance to identify the research question and the target audience if they are present. The presence of a research question in the analyzed case study partly indicates the degree of complexity of the represented AI system. An AI system composed of multiple methods, applications and diverse and broad knowledge will be considered and built as an actual project with its research question rather than treated as a single-task algorithm.

5.4. Process

As for the process macro-category, the goal is to indicate the input and output categories. What matters is the qualitative part of describing the experience linked to the various stages of the process, which vary according to the type of AI system and the creative and narrative components.

5.5. Other Resources

Finally, the macro-category of other resources plays a marginal and optional role within the overall table but helps the designer keep track of practical information, such as links to external resources and keywords that help better identify the case study under analysis to similar ones. This category acts as a utility to navigate the framework and have external resources at hand to access.

In the context of IDN, the defined analytical framework acts as a systematic taxonomy meant to simplify the complex and heterogeneous knowledge of collaboration between designers and AI systems. The primary goal is to deliver crucial information to designers, allowing them to navigate the AI support system IDN landscape with knowledge and intent. This, in turn, encourages collaboration and potential co-creation opportunities between designers and AI support systems, leading to the development of robust IDN products. Individuals with experience in the three domains engaged in this contribution, namely Design studies, HCI, and Narrative studies, could further examine the framework's internal categories and overall structure. This underscores the rationale behind our initiation of a series of interviews with distinguished experts to enrich and refine the framework through their invaluable insights and perspectives.

6. Interviews Highlights and Discussion

Following the establishment of the framework proposal, an assessment of its categories and structure was undertaken through the administration of eight semi-structured interviews involving experts and academics specializing in disciplines relevant to IDN. This section presents a succinct summary of the key highlights resulting from the coding process of the interviews, facilitated by the utilization of *Quirkos*[9] software. This software enabled the creation of clusters comprising recurring topics, allowing for the systematic coding of textual data. The identification of overlapping topics and the extraction of noteworthy quotes informed the generation of Table 3. The subsequent analysis of the findings is approached critically, with the overarching objective of refining and enhancing the framework.

[9] Quirkos, is software that allows for qualitative data analysis, producing a clustering and visual representation of the data. For more info, visit https://www.quirkos.com/ (Quirkos, n.d.)

6.1. Setting the Stage

In relation to the interview phase, it is noteworthy that these sessions transpire subsequent to the culmination of the analysis of the case studies and the subsequent proposition of an analytical framework. A total of eight semi-structured interviews (Dearnley, 2005) were conducted with the primary aim of assessing the efficacy of the aforementioned framework. The participants enlisted for these interviews were drawn from the academic world, possessing expertise in at least one of the three disciplinary domains constituting the IDN discipline, as outlined in Table 2.

Table 2: The domain of expertise and its associated academic interviewees.

Interviewees	Design Studies	HCI	Narrative Studies
Dr. Carmen Bruno (Politecnico di Milano)	X		
Dr. Christian Roth (University of the Arts Utrecht)	X		
Dr. Francesca Arnavas (University of Tartu)			X
Dr. Lissa Holloway Attaway (Utrecht University)	X		X
Dr. Marco Colombetti (Politecnico di Milano)		X	
Dr. Paul Groth (University of Amsterdam)		X	
Dr. Peter Kristòf Makai (Kazimierz Wielki University)	X		X
Dr. Vincenzo Lombardo (Università di Torino)	X	X	

Source: (Serbanescu, 2024).

The interviews are characterized by a structured format, employing a predefined set of questions as a foundational guide. This questionnaire encompasses general inquiries regarding the framework posed uniformly to all participants, alongside more detailed queries tailored to specific facets of the framework, stratified according to the participants' disciplinary affiliations. Noteworthy is the online modality of these interviews, conducted through the *Teams*[10] and *Zoom*[11] platforms. Each interviewee is furnished with a virtual space on a *Miro*[12] board, housing an editable version of the framework, an exemplar application thereof, a terminological glossary, and interactor's instructions. This virtual space serves as a visual aid, facilitating a comprehensive comprehension of the framework and enhancing responses to posed inquiries. After the transcription of the interviews, the coding process had been executed utilizing the *Quirkos* software, which streamlines the categorization and analysis of emergent themes and topics.

6.2. The Findings

Table 3 provides a detailed overview of the primary outcomes, primarily centered around the theme of divergent opinions expressed by individual interviewees. Upon comprehensive examination of the framework, participants

[10] Teams is a collaboration platform developed by Microsoft, designed to facilitate communication and teamwork within organizations. Visit here the website https://www.microsoft.com/en-us/microsoft-teams/group-chat-software. (Microsoft Teams, n.d.)

[11] Zoom is a video conferencing and online collaboration platform that facilitates virtual communication and meetings. Visit here the website https://zoom.us/it (Zoom, n.d.)

[12] Miro is also a collaborative, versatile platform which allows anyone to access it by sharing the link. For more info, visit https://miro.com (Miro, n.d.) The used Miro board can be found here: https://miro.com/app/board/uXjVOruCdnA=/

articulated a sense of being overwhelmed by its intricacies, prompting a collective call for simplification. When directed towards specific categories, respondents recommended the inclusion of illustrative examples to facilitate comprehension, suggesting either the expansion of existing categories or the incorporation of descriptive elements. This feedback underscores a delicate tension between the imperative to maintain complexity for comprehensiveness and the need for simplification for accessibility.

Table 3: Table of main findings of the semi-structured interviews.

Interviews' Insights
1. The inherent challenge lies in navigating the delicate balance between the intricate nature and the need for simplification in the contents of the framework.
2. A requisite for enhanced comprehension involves incorporating additional illustrative instances. Interviewees underscored the utility of leveraging examples from existing AI support systems to elucidate specific concepts.
3. There is a discernible demand for elucidations and deeper insights into the overarching objectives and intended targets of the framework.
4. Respondents possessing advanced engineering acumen advocate for a framework that prioritizes the practical application of the AI system rather than its underlying mechanisms.
5. Divergent viewpoints emerge regarding the same clusters, reflecting a polarized stance on their effectiveness or relevance.
6. A notable disparity arises between positive sentiments expressed about the framework's general overview and the critical concerns raised when scrutinizing the framework in finer detail.

Source: (Serbanescu, 2024).

A notable suggestion arising from the interviews is the incorporation of case studies to elucidate the glossary, offering a pragmatic solution to enhance understanding without augmenting the inherent complexity of the framework. This contrasts with the potential pitfalls associated with the continued expansion of categories and subcategories, which threatens to exacerbate the perceived complexity. Despite the evident organizational coherence and efficacy of the framework, there exists an opportunity for improvement in its visual representation. Recommendations put forth by interviewees advocate for enhancing the graphical depiction of the analytical framework. Dr. Bruno, for instance, highlights the prospect of optimizing the use of color codes to demarcate different sections, aiming to streamline the reading process. This sentiment is echoed by Dr. Roth, who emphasizes the need for clearer differentiation between categories. Dr. Attaway goes a step further by suggesting an exploration of color coding to assign distinct colors to categories based on their relative significance, thereby enhancing visual clarity. Additionally, to enhance conceptual comprehension, particularly regarding clustered topics and the overall compilation of the framework, another suggestion posits the provision of a pre-compiled version of the framework. This tailored version would cater to designers seeking a more succinct and readily accessible rendition of the framework.

In summary, the evaluation of the framework through expert interviews unveiled a nuanced interplay between the necessity for complexity and the demand for simplicity. The tension identified necessitates careful consideration in future iterations, with proposed solutions centered around the strategic inclusion of examples, case studies, and alternative versions of the framework to strike a harmonious balance between comprehensiveness and accessibility.

7. Conclusion and Further Developments

The framework presented in this paper is a qualitative analysis framework to identify and classify AI systems that support the designer who designs with *AI Co-creativity Support Systems for IDNs*. It is a dual-function framework that maps the area of the existing AI support systems for IDNs. Likewise, it is an awareness table concerning the functioning of the AI system employed. The framework can help design the AI support system intended to be

built, as it provides an overall macro-structure and detailed categorizations that can stimulate the design and implementation of an authoring tool for rather complex IDNs. It, therefore, lays the foundations for understanding the necessary elements that an *AI Support System for IDNs* should have. Its application lies in constructing a record of case studies, of which examples are provided in section 4, which designers and anyone interested in or doing research in the field can access and further use to extend it. As a prospective trajectory of this investigation, the aim is to operationalize the conceptual framework through the assimilation of findings derived from conducted interviews and subsequent empirical examinations in the design practice. This incorporation will involve active collaboration with designers who express a willingness to engage alongside AI systems in the collaborative creation of IDNs.

The research identifies a newly emerging type of *AI support system* that creatively supports the designer in creating IDNs beyond systems that perform tasks and suggest options that can rarely be recognised as creative solutions and are not the result of continuous human and AI collaboration. The creativity does not lie in the automation tasks but the mutual joined forces between the two parties. For this to happen, the collaboration from a designer's perspective must be aware and directed toward a common explicit goal for both parties involved; otherwise, obtaining a co-creative IDN experience is difficult. With this framework, we want to invite academics and practitioners to expand the potential of AI support systems that can fill unexplored areas such as those of narrative worlds built thanks to the support of AI systems or emerging ones such as *AI Co-creativity Support Systems for IDNs*. A significant exploration space became apparent after the outlined case study, which showed that only 7 out of 60 investigated AI support systems can be considered *AI Support Systems for IDNs*. Therefore, the research aims to open a new path of study and analysis that sees the exploration of *AI Support Systems for IDNs* in a co-creative way, and the framework can be used as a starting point for this exploration.

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