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When did I lose them? Using Process Mining to study user engagement in Interactive Digital Narratives

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Abstract. This work aims at capitalizing advances in the field of Process Mining applied to the domain of Interactive Digital Narratives (IDN), towards the understanding of user engagement, particularly, spotting when and what happened when user engagement dropped. An online IDN system was adapted to implement an engagement sampling protocol, probing 74 users for Continuation Desire during runtime. The playtest dataset was coupled with the engagement self-reports and analyzed using Process Mining. We identified a subset of User-Initiated Actions associated with higher engagement trajectories, as well as actionable feedback for improving the system. We consider Process Mining as an asset for the evaluation of IDN systems and the characterization of the Interactive Narrative Experience.

Keywords: Continuation Desire, Engagement, Process Mining, Interactive Narrative Experience, User Research.

1 Introduction

Interactive Digital Narrative (IDN) is a computer-based media that empowers users to causally influence the course of the unfolding narrative events in a story world, mediated by a storytelling engine [3, 4]. This intentional influence, known as effectance [5], would allow users to experience interactive stories in a more personal and engaging way as a result of their direct participation.

IDN systems generally rely on Drama Manager or equivalent subsystem(s) [6] employing Artificial Intelligence techniques to balance user actions and author-defined constraints. Such subsystems should be capable to provide users not only a coherent but also an appealing Interactive Narrative Experience (INE) — the user experience particular to IDN. Despite progress in the field, notably in narrative generation, the call for more research in the systematic evaluation of IDN systems and the INE is still in force [7]. We consider that the relatively novel discipline of Process Mining, whose strength lies in the generation of actual models of human-computer interaction could be an asset to the evaluation of IDN systems.

Process Mining could use playtesting datasets to automatically build Process Maps that help cross-check the expected (or theoretical) capacities of a narrative engine with real usage data, granted it is properly timestamped. Given the generative nature

of IDN systems and the multiplicity of created storylines, employing automatic analysis tools could be particularly interesting to the field. In this article, we present an experimental study focused on understanding the drops of user engagement, and briefly discuss on the potentialities of Process Mining for doing User Research of IDN systems.

1.1 When did I lose them?

The ability to understand how users interact in actuality with a system poses challenges and interests multiple stakeholders. ‘When did I lose them?’, the question that motivates this article is twofold and aims at pinpointing what happened and when during the interaction with an IDN system, that led users to a decrease in their level of engagement. By spotting and studying these drops, designers could obtain actual contextual feedback on how users interact with their systems and actionable insights.

2 Related Works

Continuation Desire [2] posits that even though engagement is a far-reaching term often related to motivation, enjoyment, engrossment, etc., all the previous concepts share a ‘volitional’ trait. Continuation Desire is understood as the determination, a transversal indicator encompassing the Objectives, Activities, Achievements, and Affect that drive the desire to continue making part of an interactive media experience. To sample engagement at a given point, an intrusive protocol was proposed and validated consisting of briefly pausing the execution of the experience a predefined number of times, and asking users to quantify via a Likert scale, to which extent they want to continue playing, why do they want to continue, and what they plan to do next in the game. An elevated level of Continuation Desire could then be interpreted as an indicator of the presence of engagement despite the existence of negative-valenced emotions such as frustration and anger.

Process Mining bridges Business Process Management (BPM), a discipline that deals with the modeling of the design space of business processes, (use cases and scenarios users are confronted to), and Data Mining, a discipline that treats large datasets to find patterns. Process Mining is a powerful analysis technique that goes beyond summative metrics by allowing the discovering of processes and instantiating paths of execution [1]. In Process Mining, we can distinguish Variants or unique sequences of activities, instantiations of each Variant (called Cases), and visual representations of the discovered processes (Process Maps).

3 Experimental approach

A study was set up online using Prolific¹, a scientific crowdsourcing platform. The requirements for participating in the study were: a) age between 18 and 40, b) English

¹ Prolific. <https://prolific.ac>

as native language or equivalent, c) having completed at least secondary education. A payment of £1.50 was proposed in exchange for their 20-minutes participation. We modified the existing IDN system Nothing for Dinner to sample for Continuation Desire at three stages according to a dynamic triggering algorithm using a game-coherent look-and-feel interface that we presented in [10].

3.1 Engagement Trajectories

We defined Engagement Trajectories as paths representing the fluctuation of the self-reported level of Continuation Desire over time. We defined that user engagement at a certain point could be one of three possible Likert-scale values: High (5,6,7), Neutral (4), or Low (1,2,3). Three in-game interruptions provided us 27 possible Engagement Trajectories, from which we selected five of our interest: **Hooked** (High, High, High): Users under this trajectory experienced the highly-engaging path, **Deflated** (High, High, Neutral) featuring a gentle drop towards neutral engagement during the last part, **Betrayed** (High, High, Low) with a sharp drop in the engagement level towards the end, **Disappointed** (High, Low, Low) a strong initial desire to continue followed ‘unattached’ during the second and third interruption, and **Unattached** (Low, Low, Low), the opposite of ‘Hooked’.

3.2 Process Mining Analysis

Disco², a Process Mining software, used the resulting dataset from merging data from the narrative engine, the interruption manager, and the crowdsourcing service, as input for generating the process maps and analysis of Variants. To do so, it was necessary to do a mapping of the dataset to the corresponding process mining dimensions. Once the data loaded, we selected the User-Initiated Actions by filtering by Resource *Selector* containing *Player* as value, and we filtered per interruption and engagement values. Disco employed discovery algorithms for detecting the variants and subjacent cases that ran through it.

4 Results and Analysis

A total of 90 participants (50 males, 40 females) aged between 18 and 39 years old took part in the study ($M = 27.86$, $SD = 6.24$). From this participant pool, we removed those who did not go through one of the engagement trajectories, which resulted in a final sample of 74 participants (82% of the pool), which for the most part belonged to the *Hooked* ($n=40$) and *Unattached* ($n=17$) trajectories.

We used Disco to automatically identify Variants of User-Initiated Actions per engagement trajectory. Variants are each of the paths of execution in a process, which contains a certain number of Cases. Process Mining analysis on the traces was performed based on segments corresponding to each of the three interruptions, allowing us to ‘zoom in’ into the gameplay traces.

² Disco. <https://fluxicon.com/disco/>

We only found Variants for the *Hooked* and *Unattached* trajectories, which may be explained since these two trajectories have most of the participants ($n=57$). By inspecting in detail each Variant segment, a series of interesting observations arise from which we instantiate the following three: First, the User-Initiated Action `Wish dinner_solution`, which by design helps moving forward in the story, was strongly present in the Interruption 1 of the *Hooked* trajectory but not in the *Unattached*. Second, participants in the *Unattached* trajectory, for the most part, triggered performative activities that did not involve any other character. Finally, not finding any Variants in *Hooked*'s Interruption 3 puzzles us, since it indicates that there is no a sequence of actions that could be linked to a High Engagement. Analyzing what occurred during this interruption would require a different approach and/or additional techniques.

5 Conclusion

The nature of the AI-based systems issued in the field of Interactive Digital Narratives (IDN) affords a great multiplicity of story paths as a result of the direct intervention of the users. Such a diversity poses problems in terms of analysis of the systems and the Interactive Narrative Experience since not all the generated storylines might be interesting and engaging to the user.

We were interested in discovering when and why the user engagement had dropped during runtime in the Interactive Digital Narrative work “Nothing for Dinner” (NFD). We set up a study in which we collected telemetry data and self-reports of engagement of 74 participants during runtime, and then we employed Process Mining (PM) to discover the models and paths of interaction in the light of a set of engagement trajectories that we defined. To our knowledge, PM has not been used before for analyzing IDN systems.

Process Mining proved to be a valuable technique to discover the diverse paths in which users interact with the IDS system. Moreover, it was useful for spotting the elements of a *hooked* narrative path (high engagement), which in the case of the tested story seemed to be mostly linked to seeking the involvement of other characters in the achievement of certain activities. These leads for improvement could be implemented and further tested to validate if there is a diminishing in the number of users that exhibit drops in their engagement.

We believe that Process Mining is a new and promising approach for the automatic evaluation of different IDN systems and the advancement of the understanding of the Interactive Narrative Experience. It can provide authors and designers with powerful bird-eye analytic tools and insights on the actual interactions of the users with a complex system.

Future work may include employing Process Mining to study raises in engagement, narrative evaluation, as well as the influence of certain activities in the overall replayability, objective metrics [14], and the emotional dynamics over time using psychophysiological measurements.

References

1. van der Aalst, W.M.P.: Process Mining. (2016). <https://doi.org/10.1007/978-3-642-19345-3>.
2. Schoenau-Fog, H.: Hooked! - Evaluating engagement as continuation desire in interactive narratives. In: Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). pp. 219–230 (2011). https://doi.org/10.1007/978-3-642-25289-1_24.
3. Murray, J.H.: Hamlet on the Holodeck: the future of narrative in cyberspace. MIT Press (1997).
4. Roth, C.: Experiencing Interactive Storytelling, (2016).
5. Klimmt, C., Hartmann, T., Frey, A.: Effectance and Control as Determinants of Video Game Enjoyment. *CyberPsychology Behav.* 10, 845–848 (2007). <https://doi.org/10.1089/cpb.2007.9942>.
6. Arinbjarnar, M., Barber, H., Kudenko, D.: A critical review of interactive drama systems. *AISB 2009 Symp. AI Games*, 15–25 (2009).
7. Louchart, S., Zagalo, N.: The Challenges with Evaluating Interactive Narratives. 2–3 (2012).
8. Schoenau-Fog, H.: The Player Engagement Process: An Exploration of Continuation Desire in Digital Games. In: *Proceedings of DiGRA 2011 Conference: Think Design Play*. Digital Games Research Association (2011).
9. Kim, J.H., Gunn, D. V, Schuh, E., Phillips, B.C., Pagulayan, R.J., Wixon, D.: Tracking real-time user experience (TRUE): a comprehensive instrumentation solution for complex systems. *CHI '08 Proc. SIGCHI Conf. Hum. Factors Comput. Syst.* 443–451 (2008). <https://doi.org/10.1145/1357054.1357126>.
10. Estupiñán, S., Andkjaer, K.I., Szilas, N.: Engagement in Interactive Digital Storytelling: Sampling Without Spoiling. In: *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (2018). https://doi.org/10.1007/978-3-319-99426-0_25.
11. Bradley, M., Lang, P.J.: Measuring Emotion: The Self-Assessment Semantic Differential Manikin and the. *J. Behav. Ther. Exp. Psychiatry.* 25, 49–59 (1994). [https://doi.org/10.1016/0005-7916\(94\)90063-9](https://doi.org/10.1016/0005-7916(94)90063-9).
12. Vermeulen, I.E., Roth, C., Vorderer, P., Klimmt, C.: Measuring user responses to interactive stories: Towards a standardized assessment tool. *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*. 6432 LNCS, 38–43 (2010). https://doi.org/10.1007/978-3-642-16638-9_7.
13. Mateas, M., Stern, A.: Façade : An Experiment in Building a Fully-Realized Interactive Drama. *Game Dev. Conf. Game Des. track.* 2, 82 (2003). <https://doi.org/10.1.1.14.6176>.
14. Szilas, N., Ilea, I.: Objective Metrics for Interactive Narrative. 91–102 (2014).