Event-based Model of Narrative Structure for Games

Bethany Dunfield
Carleton University, Canada
Bethany.Dunfield@carleton.ca

Anthony Whitehead
Carleton University, Canada
Anthony.Whitehead@carleton.ca

Ali Arya
Carleton University, Canada
Ali.Arya@carleton.ca

***Abstract* - We propose a model for game narrative as the combination of story and its discourse, that can be used to both help write new game stories and evaluate existing ones. This model is based on scholarly models of narrative and narrative structuralism, with information about each narrative event and its position within the overall sequence of events making up the story. To create our model, we performed a study of existing video game stories, using the aggregate critical score as our metric for quality. Stories were broken down into their component events, and data was logged about each event's importance, whether it sourced internally from a character or externally from the plot, and whether the event corresponded to a component of narrative macrostructures such as "The Hero's Journey". Results from our analysis show a strong relationship between the ratio of internal "character-driven" events versus external "plot-driven" events and a story's quality. We were also able to make recommendations about overall story event structure, such as limiting strings of external, or "plot-driven", events.**

***Keywords* - Game Story, Narrative Models, Event**

I. Introduction

Stories are essential part of human communication. While a common model for stories features a person who faces an external struggle, they overcome these external challenges confronting some internal ones and growing toward an ultimate internal goal [1][2]. The discourse for a story is the way these struggles are organized and presented which results in the narrative. An important aspect of narrative is the concept of structure. Structuralist approaches break down narrative into its component parts and analyze the properties of each part at a variety of levels [3]. This allows for in-depth analysis of each event in the story and understanding how they come together to create a complete narrative.

Videogames are capable of supporting complex narratives, as well as both linear and non-linear story structures. However, narrative structure in video games, while significant in their success, has not been properly studied. Game development costs have increased as technological capabilities and team sizes have grown [4]. And, as costs rise, the metric for success rises as well, with games often not turning a profit unless they are top sellers [5]. Stories, while not necessary for games [1], can make a game more attractive to players [6]. Stories are a subjective domain though, which makes them difficult and potentially costly to evaluate [7].

This work is funded in part by the Social Sciences and Humanities Research Council of Canada through IMMERSe Network.

Tools for evaluating subjective aspects of games such as their narratives are lacking. We propose with this research that narrative concepts, particularly structuralism, can be used to model game stories. Our primary research question is whether this structural model can adequately describe game narrative and distinguish between or identify "good" and "bad" stories, based on differences in structural properties.

A model for game narrative analysis would have many applications, both academic and industry. In general, game story writers could benefit from a structural model, as either a starting point for their stories or a method to evaluate a written story. Larger studios with high budget and high-risk games may also benefit from a tool which could allow them to better evaluate their in-development projects and potentially reduce the risk of commercial failure. Evaluation in this way may also reduce the need for costly user testing sessions, which could lead to cost savings against the game's budget.

In academia, we see procedural generation of narrative as a field which could benefit from this model. Evaluation of content is one of the key challenges when designing content generators, particularly for subjective content such as narrative [8]. Our model could be used as a metric to evaluate generated stories against. The model could also be used in the generation process, to better inform content selection.

The major contribution of this research is the creation of a structural model for game stories. The model is event-based and contains information about the types of events within a story, and their ordering.

To create this model, we have also developed several tools with which to analyse game stories. We designed a method for discretizing game stories into their individual events and defined a list of properties that could be categorized for each event. We defined a property for story events, where an event could be either "character-driven" or "plot-driven". This categorization was designed to cover the narrative concept of internal and external character goals. We also used the structuralist properties of "Kernel" and "Satellite" to classify the importance of an event within the story.

II. Related Work

A. Narrative and Storytelling

A narrative is made up of two parts: The *story* which revolves around a plot (a set of events) [1], and the manner in which that story is told, or the *discourse* [9]. The order that the events are told may differ from the order they occur in the story. Altering the discourse of the sequence of events creates a narrative.

Good narratives can generally be boiled down to the same basic outline: a protagonist who has a goal, and who overcomes a series of difficult challenges in order to achieve it [1][2][10][11][12][13]. Stories are about people [2][3]. The actual characters may not be human, but they always should represent people (or other active entities borrowing human characteristics). Going one step deeper, the story is about the choices made by the characters and the changes they experience as a result of their journey [1][2]. These internal experiences are the true driving force of the story [2]. In strong stories, external problems and challenges thrown at the characters are related to the character's internal issues. Characters move towards overcoming their internal problems through the completion of external events [2]. For example, in Star Wars [14] or The Matrix [15] this can be seen through the struggles of Luke and Neo, for example, Luke Skywalker's external goal of joining the Jedi and stopping the Empire is rooted in his internal issues surrounding the identity of his father, and his own identity. In The Matrix [15], Neo's internal goal of understanding the truth about himself and the world around him is achieved through the external acts of learning to survive in the real world and fighting off machine.

B. Narrative in Games and Interactive Stories

Narrative is not a requirement for a game, however, games can be used as a medium to tell stories [1]. Narrative can provide strong framing for player actions within the game and can offer players motivation to continue playing [6][17][18]. This occurs both in the sense of providing the player with a desire to know "what comes next" [6], but also providing emotional context to the game's tasks.

Chris Crawford defines interactivity as "a cyclic process between two or more active agents in which each agent alternately listens, thinks, and speaks" [13]. Most non-interactive forms of storytelling are termed *linear*, that is to say, the sequence of events will occur in the same linear order every time the narrative is read.

Niesz and Holland's description of interactive narrative is that of a tree-shaped branching narrative, where player choices lead to a series of pre-authored outcomes [19]. Branching narratives have the disadvantage of requiring exponential work on the part of the writer [20].

It is important to distinguish here between the user, or in games the "player", and the character within the story. In a traditional linear story, Montfort describes this relationship as the user playing the game and directing the character, but not playing the character in the dramatic sense [21]. The author, not the player, decides the character's actions and reactions, and the player is responsible for "steering" the character through the narrative [21]. Even in interactive stories, it is important to view the player as a separate entity from the character they are operating. It is clear that, at least in games, there are two types of interactivity possible. A game is interactive by virtue of the medium, even if the player cannot affect the narrative [17]. The game story can also be interactive, or "player-driven" when the player themselves is able to exert control over the outcome of the story [1][17].

Interactivity in storytelling falls along a spectrum, from non-existent to fully user-driven narratives [17], termed "embedded" and "emergent" narratives respectively. Embedded narrative is the traditional storytelling approach: the story is pre-written, and "embedded" into the experience. Player interaction cannot change the story, and the player is much like the reader of a book [6]. Emergent narrative, on the other hand, is the narrative experience created in the player's mind based on their experiences in the game. Players create and act out narratives based on their own interests and goals within the framework of the game's capabilities. Most games combine different amounts of embedded and emergent narratives. However, even games with embedded stories will produce different emergent experiences in their players [6].

Successful player-driven narratives are rare and challenging to create. Narrative audiences will generally act to reduce tension and avoid conflict [1] and may lack personal qualities such as adequate creativity to create a compelling story [22]. Factors such as suspense and surprise are critical to good narrative [1][16], and so players are less likely to make story choices which would lead to an interesting narrative. Narrative in traditional media has often actively tried to limit or remove audience participation, in order to avoid this problem and sustain narrative immersion [23]. Explicit player control over a narrative is also not always a desired trait from the player perspective. As Glassner writes, "Audiences do not want to do the author's work" [1].

C. Narrative Structuralism

Narrative structuralists are concerned with the analysis of stories from the structural perspective and examine story events both individually and within the context of their overall placement within the discourse.

Vladimir Propp's dissection of the Russian Fairytale in 1928 was a pioneering structuralist work. Propp broke down these narratives into 31 "functions", which he found to be common between a large number of stories [11].

Joseph Campbell identified the popular macrostructure "The Hero's Journey" in his book "The Hero with a Thousand Faces" [12]. This structure divides the typical adventure plot into 17 stages. Christopher Vogler adapted and simplified Campbell's structure into a twelve-step version known now as the Writer's Journey. The Hero's and Writer's journeys propose a more rigid discourse structure compared to Propp's work, where all the functions play out in chronological list order. Not every event in a story must correspond directly with a function from one of these structures, but the overall flow of an adventure plot generally adheres to them. Games tend to gravitate towards action and adventure stories, which makes the Hero's and Writer's journey excellent choices with which to analyse game narratives [17][9].

Chatman identifies two types of story events with respect to their importance in the story: kernels, and satellites [9]. Kernels are story events which are required to understand the logic of the story. They cannot be omitted without altering the plot. Satellites are the opposite. They add to the texture of the story, but if they were to be omitted, the story would remain essentially unchanged, and could still be understood by the reader [9][3].

We proposed with this research to define an event-based model of game story structure. This model could be used as an evaluation tool for narrative generators. Such a model will include information about the types and orderings of events within game stories. We propose to define this model through a study of existing game stories. By compiling a dataset of structuralized game stories, we will be able to draw wider conclusions about the structure of game stories as a whole, both in terms of story event properties and the resultant discourse.

III. Story Event Categorization

The goal of this work is to create an event-based model of game story structure. A story is about a protagonist who has an internal goal. The protagonist overcomes a series of external goals and challenges in the hopes of achieving their internal goal [2]. We propose a categorization for story events based on this internal/external binary, using the terms "character-driven", and "plot-driven" to refer to internal and externally sourcing events respectively. Essentially, a story revolves around character-driven events performed by the characters as a reaction to plot-driven events, with both types of event driving the narrative towards the character achieving their internal and external goals [1][2].

Character-Driven Events

We consider characters within a narrative to be entities themselves, with personalities and goals that they are disposed to working towards [1]. We consider a story event which occurs as a result of a conscious decision by a character within the story to be "character-driven". The key here is that there are multiple courses of action available to the character, and it is their choice which determines how the story proceeds.

Some events can be carried out by a character or involve a character without being character-driven. The event must contain a character choice or intent in order to be considered character-driven.

Plot-Driven Events

As we have discussed above, it is the author's job to create external issues for the characters to overcome. These author-sourced events are what we term "plot-driven". These are events which happen *to* characters, as opposed to the characters driving the event.

Plot-driven events can be events that occur regardless of character actions or events which would have occurred regardless of which character(s) are involved. Even if a character performs the action, if they have no choice in the matter, the event cannot truly be character-driven. Using Cron's terminology, these are "external" events, which source from outside the character [2].

Examples

Character-Driven

Metal Gear Solid 3: Volgin orders Ocelot to shoot Snake, but he refuses, citing a promise to The Boss.
Ocelot makes the choice to refuse his orders because of a personal promise with another character.
The Last of Us: Ellie and Joel travel to meet Bill, who owes Joel a favour. Bill agrees to fix up a car if Joel and Ellie agree to help gather the parts.
Bill agrees to help Joel and Ellie but only under a condition. Because the character of Bill actually has agency here, his decision to help if his demands are met makes this a character-driven event.

Plot-Driven

The Legend of Zelda: Ocarina of Time: Link has aged 7 years, as he was too young to be the Hero of Time
This event happens TO Link, with no input from him or any other characters.
Uncharted: Drake's Fortune: Elena triggers a trap, locking Sully away from Drake and Elena.
This is a plot-driven event because Elena was not aware of the trap and did not intentionally trigger it.

IV. Research Question

Our overall question is whether a game story can be modelled structurally in a useful way. That is, can we model a successful story and distinguish it from an unsuccessful one? This overall question is comprised of many parts:

1. What components of the narrative macrostructures are present, and are the overall macrostructures we have chosen well suited to game stories?
2. Can the source of a story event, as either character-driven or plot-driven, be easily determined, and is it a useful metric for modelling story events?
3. Does this model accurately provide a picture of how events are sequenced together in a typical game story?

4. What is the relationship between the source of story events (as either character-driven or plot-driven) and their ordering, and the quality or success of the story?
5. Are there other factors which affect this relationship, such as the importance of a story event as either a Kernel or Satellite?

V. Research Method

A. Data Collection

In order to determine structural data about game stories, we analyzed 20 existing game stories. Games were selected across multiple genres. In order to draw conclusions about the analyzed stories, it was necessary for us to define some metrics for quality. Since the perception of a narrative is subjective, it is difficult to find an objective rating for quality. We decided to use the aggregate critical score of each game, drawn from a set of popular review sites (IGN, GameSpot, GamesRadar, RPG Fan, Electronic Gaming Monthly, and GameInformer). Not every game was present from every reviewer, but this allowed us to get an aggregate score of at least 3 reviews per game. While we are aware that game reviews encompass far more than just the story quality, games were selected only where the story featured prominently in the game reviews. We attempted to analyze both high and lower scoring games, to see if inferences about story structure could be made by viewing the differences between higher and lower scoring game structures.

In addition to a prominent story, we selected only embedded narrative games. Our selected games, if not fully linear, involved simple branching narratives, where each ending was fully embedded, and where there were infrequent choices/branches. Games were selected from a variety of genres, although some genres feature more prominently due to them being better suited for complex narratives. Role-playing and adventure games were most common, although first-person shooters were also analyzed.

When at all possible, games were personally played through to collect data. For games that were difficult to locate, online playthrough videos were used to experience the story. Playthroughs were chosen without any creator commentary or dialogue to influence the perception of the game story.

B. Data Analysis

For analysis, we broke down the game stories into discrete events. The "plot point" as described by Glassner [1] is the bar for a story event in our data. This is described as "when something happens to change or advance the story" [1]. We categorized each event according to several classifications, which are described below.

Character-Driven or Plot-Driven

The source of the event was determined and classified as either sourcing internally from a character or sourcing externally from the author. Character-sourced events were labelled character-driven, and author-sourced events were labelled plot-driven.

Kernels and Satellites

This categorization has to do with the importance of an event to the story. Satellites are story events which can be freely deleted from the discourse without affecting the overall structure and logic of the narrative. Kernels, on the other hand, are necessary to the narrative and cannot be omitted without changing it [9][3].

Main, Chapter, Event

"Main" events are derived from Glassner's definition of a story "arc" [1]. These events are central to the overarching plot or goal of the narrative. "Chapter" events are also turning points in the story, within the larger arc. Generally, in games, they correspond to a new level or the accomplishment of a minor goal and the switch to a new one. Remaining events are classified as "Events" and have no special properties in this categorization.

Narrative Macrostructures

Events were also categorized against three narrative macrostructures: Propp's Functions, The Hero's Journey, and the Writer's journey. If the event corresponded to a component or function of the macrostructure, it was labelled as such.

C. Visualizer Development for Preliminary Analysis

Before we completed the entire study, we performed high-level pilot analysis of our early data points in order to clarify our research questions. To that end, we developed a visualizer that allowed us to more easily view patterns in the data.

The visualizer contains three visualization styles. These visualizations are the Arc, the Character Interactions, and the Character Co-Occurrence Matrix. The Arc Visualizer was meant to graphically show the main, chapter, and event levels. The graph was event-based, meaning information would be shown along a timeline for each event within the story. The hope with this visualization was to identify obvious patterns, such as a consistent number of events per chapters. However, no useful conclusions or hypothesis were found from this visualization.

The second visualization we developed was the Character Interactions visualization (Figure 1). Again, this is a timeline-based visualization, with each event in the story appearing as a circular node along the horizontal access. Every character is delineated by a line on the graph, which is assigned a random colour to differentiate them. Whenever the character participated in a story event, their line would converge to the central axis at that event node. Character-driven and Plot-driven events were distinguished by the colour of the event node. Plot-driven events are drawn as black, while a character-driven event is coloured in the same colour as the character that "drove" the event.

We found that games with higher-rated stories tended to have more activity along the graph. These games would, on average, feature more characters, more character-driven events and characters participating in more events along the timeline. Lower scoring games featured fewer characters, more plot-driven events, and characters less frequently involved in story events. This contrast can be seen in Figure 1.

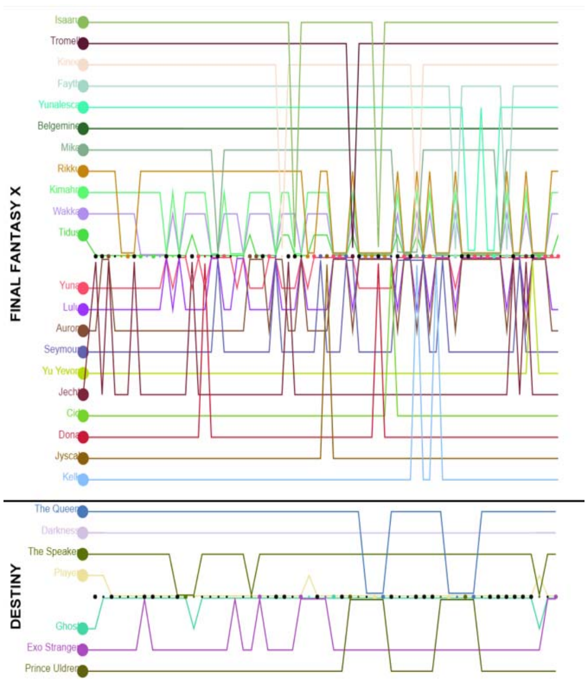

Figure 1. Character Interactions Visualization for Game Stories. The top visual shows a highly rated game story, while the bottom shows a low rated one.

We had initially hypothesized that our idea of distinguishing events as either character-driven or plot-driven would provide useful information towards our model. This visualization showed us that our hypothesis had merit, and was worth further study and analysis.

The last visualization is the character co-occurrence matrix, shown in Figure 2. This diagram illustrates the importance of the various characters within the story based on how frequently they appear alongside other characters. The more frequently the characters co-occur, the darker the square is drawn. The exact count of events where the two characters interacted is also displayed. The total number of events in the game story is displayed at the right-hand side of the visualization. Again, as found with the Character Interactions Visualization, games with higher rated stories featured more characters, particularly with more characters interacting with the game's protagonist.

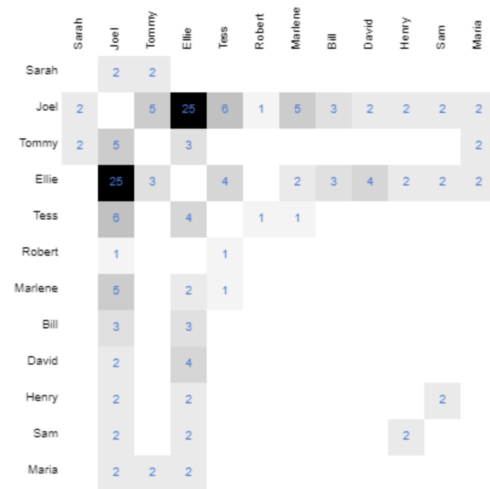

Figure 2. Character Co-occurrence Matrix for the story of "Metal Gear Solid 3".

VI. Results

The full data-set consists of 20 analyzed games. Results have been split into quantitative and qualitative categories. An overall summary of the games studied, and their aggregate critical score is listed in Table 1.

Table 1. Listing of analyzed games and their scores

Game Name	Score
Dark	41.67
Legendary	46.25
Velvet Assassin	59.38
Destiny	72.6
Gravity Rush	77.5
EtrianOdyssey 2: Untold	78.5
To The Moon	81.25
Catherine	82
FE:Fates - Conquest	83.5
Uncharted: Drake's Fortune	83.67
Shadow of Mordor	85.17
FE:Fates - Revelations	86.25
FE:Fates - Birthright	87.9
Final Fantasy X	89.5
Tactics Ogre: LUCT	89.6
Golden Sun	91.67
Batman: Arkham Asylum	92
The Last of Us	93.75
Metal Gear Solid 3	94.33
Legend of Zelda: OoT	96.25

A. Overall Results

We calculated the percentage of events within each game that were character-driven and plotted this against the aggregate critical score (Figure 3). The graph suggests that there is a correlation between a higher percentage of character-driven events and a higher resultant score. For this initial analysis, percentages were used to try and reduce bias between longer and shorter stories. Story lengths vary widely, with some stories containing fewer than 50 story events, while others feature over 100.

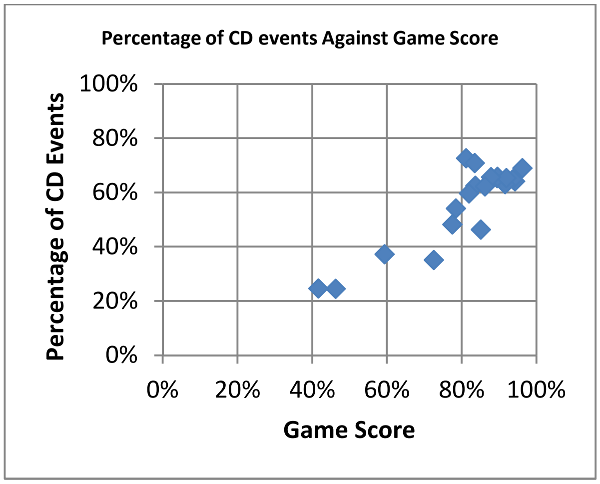

Figure 3. Percentage of Character-Driven events against Game Score

To confirm this correlation, we ran an ANOVA comparing the counts of CD and PD events for each game to its score (Table 2). Our dataset, though it appears not fully normal, is close to normal because it was selected from random reviewers, and therefore suitable for an ANOVA. The results indicate that the number of PD and CD events and the interaction between them does affect the resultant game score.

Table 2. Analysis of Variance of the count of CD and PD events, related to the game Score

	Df	Sum Sq	Mean Sq	F Value	Pr(>F)
Count PD	1	1908.7	1908.7	41.133	8.58e-06 ***
Count CD	1	1460.6	1460.6	31.475	3.91e-05 ***
Count PD:CountCD	1	257.4	257.4	5.547	0.0316 *
Residuals	16	742.5	46.4		

B. Character-Driven and Plot-Driven Probability Analysis

One of our goals is to be able to distinguish between better and worse stories within the model. To support this, a median split was done on the data, splitting the data into lower scoring and higher scoring cohorts. However, our data set is skewed towards higher scoring games, with a fairly high overall median of 84.42. The high median meant that much of the lower half of the data would still score high enough to be considered "good" as opposed to "bad", making it difficult to compare the two halves and make conclusions. Therefore, in addition to the median split, the data was also split into lower and upper thirds, with the middle third being ignored. The lower third contained games scoring from 41.67 - 81.25, while the upper third ranged from 89.5-96.25. A summary of the Median and Mean scores from these dataset splits can be found in Table 3. These values confirm that the overall dataset is "top-heavy", given that the medians and means in the upper half and upper third are much closer together than what is seen in the lower half and lower third.

Table 3. Summary of Median and Mean scores when the data set is split

	Median Score	Mean Score
Overall	84.42	80.64
Lower Half	78	70.632
Upper Half	90.64	90.64
Lower Third	72.6	65.31
Upper Third	92	92.44

We analyzed the probabilities of moving between Character-driven and Plot-driven events from these datasets. A graphical representation of this system is shown in Figures 4. Probabilities were also measured for strings of events, up to a string of 5. (Example, C-C, CC-P, CPC-C, and so on). We found that this information becomes less useful beyond a string of 3 events, as data numbers begin to thin out and probabilities become unreliable.

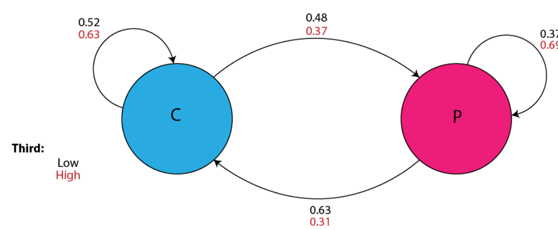

Figure 4. Markov State Machine modelling the movement between character-driven and plot-driven events, contrasted between the lower and upper thirds of the data set

Table 4 shows the probability data for 2-length strings of events. Binomial tests were run to determine if the observed probability values were significantly different from a neutral 50% value. In the unsplit dataset, character-driven events were found to occur significantly higher than 50% of the time when following a character-driven event, with a p-value of <0.0001. That is, C-C strings were more probable than C-P strings. Plot-driven events were not significantly more likely to follow plot-driven events (P-P string), with a p-value of 0.103. In the lower half of the data set, character-driven events were more likely to follow both character and plot-driven events, with p values of <0.0001 (C-C string) and 0.00259 (P-C string) respectively.

In order to determine if differences could be identified between the split data-sets, a Chi-Squared comparison was run on the character and plot-driven event counts (Table 5). Median High was compared with Median Low, and Upper Third was compared with Low Third.

Table 4. Observed Probability values for 2-tuple event strings

	Probability				
	Overall	**Lower Half**	**Upper Half**	**Lower Third**	**Upper Third**
C-C	0.60	0.59	0.61	0.52	0.63
C-P	0.40	0.41	0.39	0.48	0.37
P-P	0.53	0.42	0.67	0.37	0.69
P-C	0.47	0.58	0.33	0.63	0.31

Table 5. Chi-Squared Comparison of the Median and Third split datasets for 2 tuple event strings

Testing Proportion:	Chi-Squared	DF	P
C-C Median High vs Median Low	0.315	1	0.5745
P-P Median High vs Median Low	34.538	1	< 0.0001
C-C High Third vs Low Third	5.671	1	0.0172
P-P High Third vs Low Third	35.596	1	<0.0001

A significant difference was found between the proportion of events which follow a plot-driven event between the median high and median low datasets. There is also a significant difference between the proportions of events which follow both character and plot-driven events in the High Third and Low Third.

For 3-length event strings, the observed probability values are listed in Table 6, and a graphical representation is shown in Figure 5.

Table 6. Observed Probability values for 3-tuple event strings

	Probability				
	Overall	**Lower Half**	**Upper Half**	**Lower Third**	**Upper Third**
CC-C	0.63	0.62	0.65	0.53	0.66
CC-P	0.37	0.38	0.35	0.47	0.34
CP-P	0.63	0.55	0.69	0.51	0.71
CP-C	0.37	0.45	0.31	0.49	0.29
PC-C	0.57	0.56	0.59	0.53	0.63
PC-P	0.43	0.44	0.41	0.47	0.37
PP-C	0.45	0.35	0.70	0.31	0.73
PP-P	0.55	0.65	0.30	0.69	0.27

Binomial tests were run to determine if the observed probability values from Table 6 were significantly different from a neutral 50% value (Table 7). Only events following a PP event chain did not differ significantly from 50%.

Chi-Squared comparisons were run for the 3-tuple event strings, similarly to the 2-tuple comparisons (Table 8). When comparing the Median High and Median Low datasets, there is a significant difference between the proportion of character-driven events following CP and PP event chains. When the High Third and Low Third datasets are compared, there is a significant difference between the proportions of character-driven events which follow CC, CP, or PC event chains.

Table 7. Binomial p-values for 3-tuple event strings. All Binomial tests were "Greater".

Event Chain	Binomial p-value
CC-C	<0.001
CP-C	<0.001
PC-C	0.005678
PP-P	0.07839

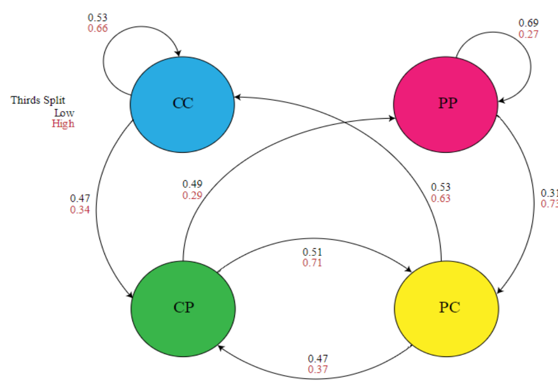

Figure 5: Markov State Machine modelling the movement between character-driven and plot-driven events in 3-tuple strings, contrasted between the lower and upper thirds of the data set.

Table 8. Chi-Squared Comparison of the Median and Third split datasets for 3 tuple event strings

Testing Proportion:	Chi-Squared	DF	P
CC-C Median High vs Median Low	0.434	1	0.5099
CP-C Median High vs Median Low	5.973	1	0.0145
PC-C Median High vs Median Low	0.275	1	0.5997
PP-C Median High vs Median Low	27.430	1	<0.0001
CC-C High Third vs Low Third	4.527	1	0.0334
CP-C High Third vs Low Third	7.516	1	0.0061

PC-C High Third vs Low Third	1.929	1	0.1649
PP-C High Third vs Low Third	23.917	1	<0.0001

In 4-tuple and beyond event strings, as mentioned above, sample sizes deteriorate to the point where statistical analysis is not useful.

The overall probabilities of moving between character and plot events were run for every game individually. Some clear trends can be seen in all games. The number of PP-P event strings, for example, decreases rapidly as the game's score increases (Figure 6). Lower scoring games contain much more frequent and longer plot event strings when compared to higher scoring games. Interestingly, 95% of game stories within the dataset begin with a plot-driven event.

C. Narrative Macrostructures

We performed an analysis of our data against the narrative macrostructures (The Hero's Journey, The Writer's Journey, and Propp's Functions). For the following analysis, the frequency of each function within the data was found, alongside the frequency with which each function was a character-driven or a kernel event. A binomial test was run to see if the frequency of the character-driven or kernel events differed significantly from 50%. Table 9 shows example data from The Writer's Journey. Results that are significant are highlighted. A "greater" binomial test was used, indicating that for significant events, the probability of being the given event-type (either CD or Kernel), was significantly greater than 50%. A * beside the value indicates that a "lesser" binomial test was used instead. A dash indicates the test was not run due to inadequate sample size.

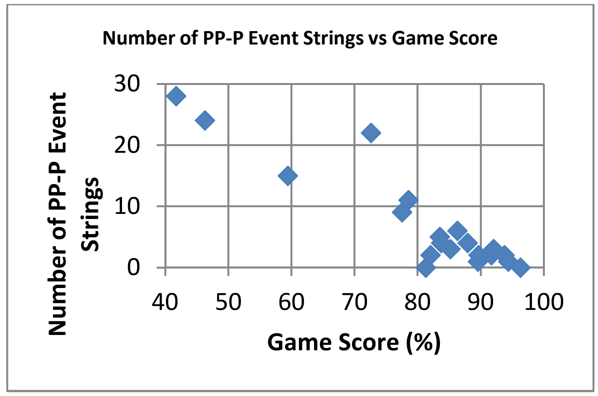

Figure 6: Number of PP-P Event Strings plotted against Game Score.

When the data was split into thirds, sample sizes were too small to gain meaningful test data from most macrostructure elements. We were, therefore, unable to perform comparisons between high and low scoring games and how the narrative macrostructures apply differently.

With Propp's Functions, many functions were present so rarely that statistical analysis couldn't be done on the overall dataset. Very few functions significantly differed from 50% for CD / PD, however, many functions were significantly higher than 50% chance to be a kernel.

Table 9. The Writer's Journey Structural Data within the Dataset

Function	Count	CD	Kernel	Occurrence Per Game	Binom p value (CD)	Binom p value (Kernel)
Ordinary World	16	0	9	0.80	<0.0001	0.4018
Call to Adventure	22	11	20	1.10	0.5841	<0.0001
Refusal of the Call	7	6	2	0.35	0.0625	0.2266
Meeting with the Mentor	15	8	10	0.75	0.5	0.1509
Crossing 1st Threshold	20	16	12	1.00	0.005909	0.2517
Tests Allies Enemies	168	99	74	8.40	0.01248	0.07123 *
Approach to the Inmost Cave	20	12	18	1.00	0.2517	0.0002012
The Ordeal	19	16	17	0.95	2.21E-03	0.0003643
Reward	15	10	13	0.75	0.1509	0.003693
The Road Back	10	7	6	0.50	0.1719	0.377
The Resurrection	18	15	14	0.90	0.003769	0.01544

D. Conformance to Macrostructures

The best fitting narrative macrostructure is the Writer's Journey. Two of the 12 functions, the "Refusal of the Call" and "The Road Back", have an occurrence per game of 0.5 or less. Otherwise, all functions within The Writer's Journey are well represented. The Call to Adventure, Crossing the 1st

Threshold, Tests Allies Enemies, and Approach to the Inmost Cave all have occurrences per game of 1.0 or higher.

For The Hero's Journey, five of the 17 functions had an occurrence per game of 0.5 or less (Refusal of the Call, Refusal of the Return, The Magic Flight, Rescue from Without, Crossing the Return Threshold). Therefore, while the Hero's Journey is not as good of a fit as the Writer's Journey, the bulk of the structure is still present in most game stories that were analysed.

Propp's functions did not appear as consistently within the dataset. However, Propp himself wrote that all 31 functions were not required to be present in order to create a story, just that events within stories could all be classified to these 31 functions [11]. However, the large variance in occurrence per game between the functions, as well as the low number of functions appearing in most stories, leads us to conclude that this macrostructure is not as useful for generation as the Hero's and Writer's Journeys.

VII. Discussion

The narrative Macrostructures used in our analysis were Propp's functions, The Hero's Journey, and The Writer's Journey. We found the Writer's Journey to be the best fit for the game stories we analyzed. The Hero's Journey was a moderate fit. Propp's functions were not a good macrostructure to model our game stories.

We proposed a categorization for story events, identifying them as either character-driven or plot-driven. This categorization was developed from existing research and theories distinguishing internal and external character goals. We performed a pilot analysis of game stories with our visualizer. This led us to question whether higher quality game stories would feature more character-driven events.

The results of our analysis of character-driven and plot-driven events showed that a game story is mainly powered by character-driven events, but the characters are still at times pitted against external events. Our qualitative analysis confirmed that lower quality stories featured more plot-driven events and plot-driven events that were less connected to character goals. Character goals were also less often present or identifiable in lower scoring games.

We found that 95% of the stories in our data began with a plot-driven event. The probability data we produced for 2-event and 3-event strings provide strong models for how events should be sequenced with respect to character-driven and plot-driven events.

We found the Writer's Journey and the Hero's Journey to be useful structures to inform the sequencing of events, with the Writer's Journey being a better fit than the Hero's Journey. We were able to assign probable categorizations of our other variables (Character-Driven / Plot-Driven, Kernel / Satellite) to each of these components. If the macrostructure is used to guide the overall arc of the story, these component points can be used to inform generator content along the way.

Our results show a clear relationship between the number of plot-driven and character-driven events in a game with its aggregate critical score. We found that a higher proportion of Character-Driven events was associated with a higher critical score. It would be tempting to conclude that the strongest game stories would eventually eliminate plot-driven events altogether in favour of a purely character-driven story. However, it is important to note that even the highest scoring games in our dataset still had roughly 20-30% plot-driven events. This is in-line with the narrative theories we have discussed which state the necessity for some plot-driven events.

Our finding that a higher percentage of character-driven events led to a higher overall game score held true when applied to just kernel events. That is, if satellites are removed from the analysis, we found that a higher percentage of kernel events being character-driven was also associated with a higher game score.

Our overall question was whether a game story could be modelled structurally. We discovered early on with our visualization tool that the Main / Chapter / Event categorization was not useful. However, statistical testing on the other elements allowed us to confirm that the Character-Driven / Plot-Driven, Kernel / Satellite, and Hero's Journey and Writer's Journey Macrostructures were useful towards creating a game story model.

We found that a Plot-Driven event is typically used at the start of the story. We recommend The Writer's Journey to guide the overall progression of the story. Event structure from event to event should be based on the probability values we observed. This decision can and should be overridden by other parts of the model, such as the limitation on P-P-P (and longer) event strings, or macrostructure data.

We were able to distinguish between high and low rated stories through some metrics, but not through others. We were able to show a significant difference in the percentage of character-driven events between top rated and low rated games. We were also able to observe differences in event sequencing, particularly with strings of plot-driven events. Longer strings of plot-driven events are less frequent in higher scoring games. We were also able to identify significant differences in the probabilities of moving between character-driven and plot-driven events between our highest scoring and lowest scoring games. We were unable to make comparisons between high and low scoring games and their usage and conformance to narrative macrostructures.

Our model can be useful to game story writers across a variety of backgrounds and development environments. The model can be used as both a framework and an evaluation tool. As a framework, it gives recommendations to writers on how to structure their stories, and what types of events should be present in different parts of the narrative. The model can also be used to evaluate a narrative after it has been written. This may help writers who wish to improve upon an existing draft of their game story. Larger studios with high budget games might benefit from a tool which could allow them to mitigate potential failures early on in the development cycle.

VIII. Conclusion

We modelled a game story as a sequence of events, with each event having properties which would inform the content of that event. We defined the Character-Driven/Plot-Driven categorization and we were able to observe a difference in this metric between high and low scoring games. This suggests that our categorization is useful for game story analysis/generation. We were also able to confirm that Kernel/Satellite, and The Writer's Journey are useful classifications to game structures. We were able to model the ordering of story events based on these properties and make recommendations as to the structure a generator should aspire to when creating a narrative.

Our work builds on the notions of kernel vs. satellite events [9][24], and other event-based studies of game narrative [24][25], and proposes extensions through models using CD/PD events and offers evidence on the effectiveness of these concepts in studying game narrative.

Our methodology had some weaknesses that could be rectified in future work. A future study could feature more robust data collection methods. Additionally, the sample size could be made larger, with a focus on gaining more titles across the spectrum of critical scores. When trying to compare high and low scoring games, not every test that we used gave a statistically valid result, due to small sample sizes. However, our reliance on critical scores is also a potential source of weakness, as the score encompasses other factors of the game not related to the narrative. A future work should spend the time to determine if a more effective measure of story quality can be found.

References

[1] A. Glassner, *Interactive Storytelling: Techniques for 21st Century Fiction*. 2004.

[2] L. Cron, *Wired for Story*. Ten Speed Press, 2012.

[3] R. Barthes, "An Introduction to the Structural Analysis of Narrative," *New Lit. Hist.*, vol. 6, no. 2, pp. 237–272, 1975.

[4] W. D'Angelo, "EA: AAA Development in Decline," 2013. [Online]. Available: http://www.vgchartz.com/article/251108/ea-aaa-development-in-decline/. [Accessed: 08-Jul-2017].

[5] C. Morris, "As Video Game Development Costs Rise, So Do Risks," *CNBC*, 2010. [Online]. Available: https://www.cnbc.com/id/35932496. [Accessed: 04-Jan-2018].

[6] K. Salen and E. Zimmerman, *Rules of Play: Game Design Fundamentals*, vol. 51, no. 3. 2004.

[7] B. Kybartas and C. Verbrugge, "Analysis of ReGEN as a Graph Rewriting System for Quest Generation," vol. 6, no. 2, pp. 228–242, 2013.

[8] N. Shaker, J. Togelius, and M. J. Nelson, *Procedural Content Generation in Games: A Textbook and an Overview of Current Research*. 2014.

[9] S. Chatman, *Story and Discourse: Narrative Structure in Fiction and Film*, vol. 34. 1978.

[10] M. A. Picucci, "When Video Games Tell Stories: A Model of Video Game Narrative Architectures," *Caracter. Estud. Cult. y Criticos la Esfera Digit.*, vol. 3, no. 2, 2014.

[11] V. Propp, "Morphology of the Folk Tale," *Folklore*, 1928.

[12] J. Campbell, *The Hero with a Thousand Faces*, vol. 63, no. 247. 1949.

[13] C. Crawford, *On Interactive Storytelling*. 2013.

[14] G. Lucas, *Star Wars Episode IV: A New Hope*. 1977.

[15] L. Wachowski and A. Wachowski, *The Matrix*. 1999.

[16] W. F. Brewer and E. H. Lichtenstein, "Stories are to entertain: A structural-affect theory of stories," *J. Pragmat.*, vol. 6, no. 5–6, pp. 473–486, 1982.

[17] J. Lebowitz and C. Klug, *Interactive Storytelling for Video Games*. 2011.

[18] H. Qin, P.-L. Patrick Rau, and G. Salvendy, "Measuring Player Immersion in the Computer Game Narrative," *Int. J. Hum. Comput. Interact.*, vol. 25, no. 2, pp. 107–133, 2009.

[19] A. Niesz and N. Holland, "Interactive Fiction," *Crit. Inq.*, vol. 11, no. 1, 1984.

[20] J. D. Bolter and M. Joyce, "Hypertext and creative writing," *Proceeding ACM Conf. Hypertext - HYPERTEXT '87*, no. November, pp. 41–50, 1987.

[21] N. Montfort, "Fretting the player character," in *Second person: Role-playing and story in games and playable media*, 2007, pp. 139–146.

[22] S. Chauvin, G. Levieux, J. Y. Donnart, and S. Natkin, "Making sense of emergent narratives: An architecture supporting player-Triggered narrative processes," *2015 IEEE Conf. Comput. Intell. Games, CIG 2015 - Proc.*, pp. 91–98, 2015.

[23] J. H. Murray, *Hamlet on the Holodeck*. 1997.

[24] E. Aarseth, "A narrative theory of games." *Proceedings of the international conference on the foundations of digital Games.* ACM, 2012.

[25] P. Harrigan and N. Wardrip-Fruin, *Second person: Role-playing and story in games and playable media*. The MIT Press, 2010.