

# Character Networks for Narrative Generation: Structural Balance Theory and the Emergence of Proto-Narratives

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## Abstract

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This paper models narrative as a complex adaptive system in which the temporal sequence of events constituting a story emerges out of cascading local interactions between nodes in a social network. The approach is not intended as a general theory of narrative, but rather as a particular generative mechanism relevant to several academic communities: (1) literary critics and narrative theorists interested in new models for narrative analysis, (2) artificial intelligence researchers and video game designers interested in new mechanisms for narrative generation, and (3) complex systems theorists interested in novel applications of agent-based modeling and network theory. The paper is divided into two parts. The first part offers examples of research by literary critics on the relationship between social networks of fictional characters and the structure of long-form narratives, particularly novels. The second part provides an example of schematic story generation based on a simulation of the structural balance network model. I will argue that if literary critics can better understand sophisticated narratives by extracting networks from them, then narrative intelligence researchers can benefit by inverting the process, that is, by generating narratives from networks.

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## 1 Introduction

Throughout this paper, I will make extensive use of concepts from social network analysis and structural balance theory. The basic unit of analysis in structural balance theory is the *triad*, defined as a triangular configuration of friendship and enmity ties between three mutually connected nodes. Some triad configurations are socially unstable and, when embedded in networks with many interdependencies, may trigger cascading social events. These cascades, I will argue below, can be treated as a proto-narrative—the skeleton of a story from which complex social dramas may be constructed.

My approach to narrative is loosely inspired by a variety of sources.

In *Deceit, Desire, and the Novel* (1961), literary critic René Girard argues that a defining feature of the novel as a modern story-telling form is the way characters' desires are embedded in and mediated by indirect social relations. Taking Cervantes' *Don Quixote* as the prototype for the modern novel, Girard asserts that Quixote's desire is "triangular":



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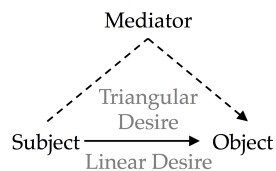
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The straight line is present in the desire of Don Quixote, but it is not essential. The mediator is there, above that line, radiating toward both the subject and the object. The spatial metaphor that expresses this triple relationship is obviously the triangle. [10]

Girard argues that in novels such as *Don Quixote*, the subject desires the object not because of its inherent qualities, but because some third character, the mediator, also desires the object. The mediator may be a role model who the subject intentionally imitates, or he may be a character against whom the subject competes for the desired object, as with a rival in polite society, romance, or commerce. In either case, the dyadic relationship between subject and object cannot be understood without reference to the mediator. While I will not use the concept of “triangular desire” directly, I will adapt Girard’s general interpretive framework by drawing a parallel between the idea that triads of characters are the basic unit of narrative analysis and structural balance theory’s assumption that triads of nodes are the basic unit of network analysis.



In *Identity and Control: How Social Formations Emerge* (2008), network theorist Harrison White posits that “social networks emerge only as ties mesh with stories” [25]. White suggests that social ties ought to be thought of multi-dimensionally in terms of “netdoms”: “‘dom’ from domain of topics and ‘net’ from network relations.” When two social agents encounter one another, they struggle for recognition and status by “switch[ing] from netdom to netdom, finding footings in different networks in differing domain contexts.” Two co-workers, for example, might initially relate to one another professionally, but then switch between political, religious, or even romantic domains as the social tie between them evolves. The more “netdom switchings” occur, the more complex and nuanced the relationship between the identities becomes. Over time, these switchings settle down into a stable tie that is comprehended by the participants via a “story”. White summarizes the process as follows:

A story is a tie placed in context. Stories structure switchings into accounts with a beginning, middle, and end; so story-making frames social time. . . . These relations are characterized by stories told in and about them with meanings drawn from the switchings between netdoms. . . . A network can be traced as similar stories appear across a spread of dyads. [25]

White’s notion of “netdom switchings” provides another potential link between structural balance theory and narrative. As the unstable triads in a structural balance network evolve towards stability, the edges connecting each pair of nodes undergo a simplified version of domain switching, oscillating between friendship and enmity. Following White’s logic, the more frequently a link in a triad switches, the more complex and nuanced the relationship between the associated node-characters becomes, gradually forming a story-tie.

I instantiate the structural balance model in NetLogo, an interactive development environment for agent based modeling, and run the simulation forward in time under different parameter configurations, producing a range of possible proto-narrative event sequences that vary in length and outcome. My use of simulation to generate proto-narratives is influenced by the work of computational social scientists Joshua Epstein and Robert Axtell. In *Growing*

*Artificial Societies* (1996), the authors describe how their now canonical “Sugarscape” model, originally constructed to study the emergence of wealth inequality, can generate “proto-histories”—schematic social and cultural histories in which individuals agglomerate and form tribes, battle, and trade. Although they do not use the term, Epstein and Axtell argue, in effect, that each run of the Sugarscape model is analogous to an historical narrative.<sup>1</sup> Although simulations such as Sugarscape are now widely used in the social sciences, practitioners rarely if ever discuss the idea that the temporal progression of a simulation can be treated as a narrative. Epstein and Axtell emphasize moreover that they “grow this history ‘from the bottom up.’” [3] That is, their proto-historical narratives are complex adaptive systems (CAS) displaying the property of emergence.<sup>2</sup> Structural balance models provide a similarly CAS-based approach to narrative generation. Unstable triads update based on local stability rules, yet produce a narrative chain of events tracing the formation of global network structures (see the discussion of “social mitosis” below).

## 2 From Narratives to Networks

Over the past several years, literary critics have begun researching the relationship between social networks and narrative structure, including several efforts to extract character networks from literary works [8, 20, 22]. The guiding principle behind literary network analysis is that narratives are not merely depictions of individual experience in language but are also artificial societies whose imaginary social forms can be quantified and analyzed. What such analyses reveal is that narrative structure, such as plot, genre, and characterization, is intimately related to network structure.

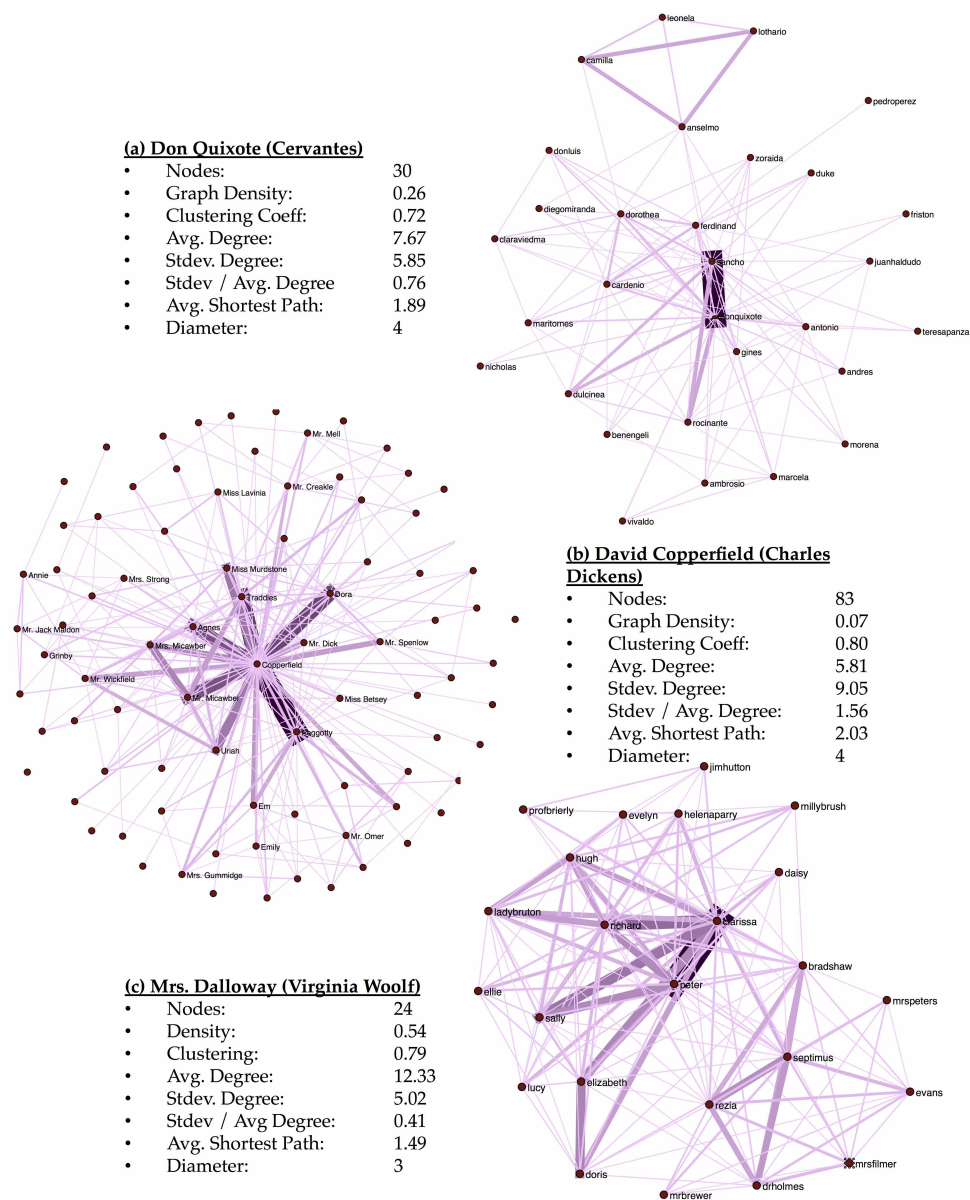
Included below are examples drawn from my own research on literary networks. Figure 1 shows the sociograms<sup>3</sup> for several canonical European novels: Cervantes’s *Don Quixote de la Mancha* (1605), Charles Dickens’s *David Copperfield* (1850), and Virginia Woolf’s *Mrs. Dalloway* (1925). Noticeable contrasts between these networks reflect key differences in literary conventions across historical periods and genres.

*Don Quixote*, widely regarded as the first modern novel, possesses an episodic plot structure derived in part from the picaresque story-forms popular during the Spanish Golden Age. It consists of a series of adventures that all feature the iconic knight and his squire but which are otherwise minimally connected in terms of plot. *Don Quixote*, moreover, operates as a frame narrative, encompassing many interpolated stories-within-the-story—such as Cardenio’s autobiography or the pastoral poems describing Marcela. The sociogram reflects this disconnected plot structure. The network is centered on a main axis connecting Don Quixote and Sancho, which is embedded in a diffuse web of characters that extends outwards in several layers. For a relatively small network, it has a high diameter, indicative of the fact that it is effectively a network of networks: when Don Quixote meets another character, such

<sup>1</sup> In a chapter subtitled “The Emergence of History”, Epstein and Axtell write, “The basic aim of this chapter is to “grow” a very simple caricature of history—a “proto-history” if you will. . . The social story is as follows: In the beginning, there is a small population of agents. . .” [3]

<sup>2</sup> “Emergent narrative” is an overloaded term. Researchers in interactive narrative use the phrase, along with “character based narrative”, to refer to minimally plotted stories generated spontaneously through live user interaction (see Aylett 1999 [4]). My meaning is drawn from complex systems theory and refers to the emergence of systemic properties from local interactions. A connection could be drawn—one might argue that human interactions with non-player characters in virtual reality environments exhibit CAS-like behavior—but the terms are not trivially synonymous.

<sup>3</sup> Social networks are generated for each novel by running a 10-word window through the text and counting the number of times each pair of character names co-occurs. Edges are drawn for pairs with greater than 3 co-occurrences and are weighted by frequency.



■ **Figure 1** Character Network Sociograms for three illustrative novels.

as Cardenio, often this new acquaintance temporarily assumes the role of narrator, relating a micro-narrative with its own stand-alone character network not linked to the original action. We can see this most clearly in the presence of several peripheral cliques, particularly the one between Anselmo, Lothario, Camilla, and Leonela, whose tale appears in a found manuscript read aloud by Quixote's priest. Moreover, the network contains a low proportion of "strong ties": aside from the heavily weighted edge between the knight and his squire, most edges are thin and light, indicating brief, glancing interactions with secondary characters who provide color and variety in particular episodes but who rarely recur or interact significantly with one another.



*David Copperfield* is one of the preeminent examples of the 19th Century *Bildungsroman*, depicting the education and development of its eponymous protagonist as he finds his way in the world, seeking benefactors, a career, and a marriage partner. Like many serialized mid-Victorian novels, it features an expansive cast: the network consists of 83 nodes, with a high proportion of isolates and low graph density (7%). The network is highly centralized with an obvious star-shape, reflecting an egocentric focus on its protagonist, who is the hub for virtually all character interactions. This accounts for its very high standard deviation in node degree, indicative of inequality in connectedness and social importance. The prevalence of strong ties is noticeably greater than in *Don Quixote*, illustrative of the 19th Century *Bildungsroman's* concern with complex relationships developed over a long duration, rather than the brief encounters with strangers common in the Renaissance-era picaresque.

The character network for *Mrs. Dalloway* contrasts noticeably with the others. While mid-Victorian novels often featured sprawling casts, the network for *Mrs. Dalloway*, a canonical work of high British modernism, is delimited. The focus is on psychological depth rather than sociological breadth. The sociogram consists of a single large component with no isolates and a very high graph density (54%) and clustering coefficient (79%), reflecting embedded relationships between characters with many common social ties. Unlike *David Copperfield*, the narrative is not singularly focused on its title character: point of view shifts approximately every ten pages. The network, correspondingly, does not have a pronounced center: it is bifurcated into two cliques—one concentrated around Clarissa Dalloway and the other around her narrative alter-ego, Septimus. Moreover, the network has a low standard deviation in node degree, indicating that character interaction is broadly and evenly distributed across the ensemble. Lastly, the diagram exhibits a high proportion of strong ties. The overall picture is that of a tightly knit social world focused on the intimate relationships between a small set of equally significant characters.

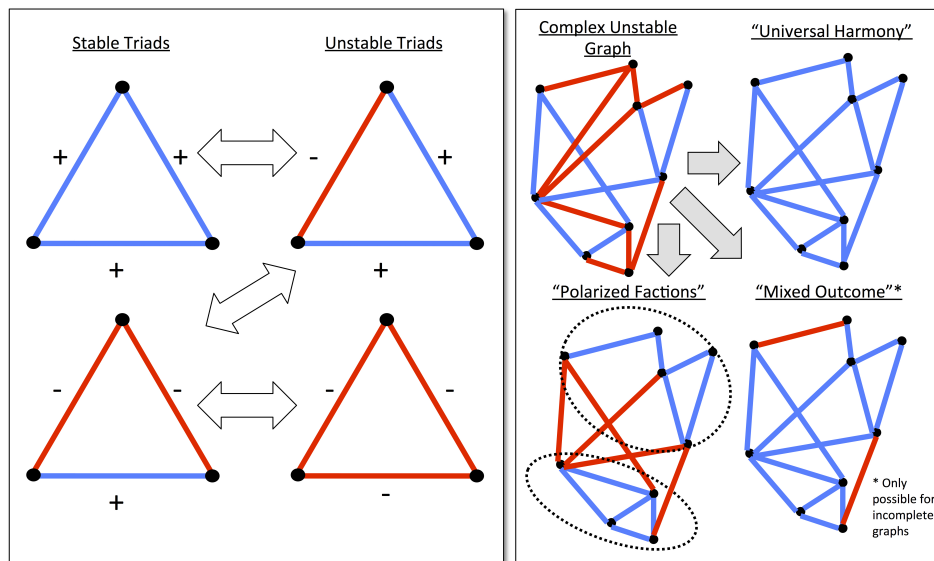
As these brief examples suggest, there is a close association between narrative structure and network structure. Authorial decisions related to linear vs. episodic plot or the balance of focus between protagonist and ensemble are visible in network properties such as centralization, graph density, diameter, clustering, and prevalence of strong vs. weak ties. But if literary critics can better understand sophisticated narratives by extracting networks from them, perhaps narrative intelligence researchers can benefit by inverting the process, that is, by generating narratives from networks.

### 3 From Networks to Narratives

In the remainder of this paper, I offer a simple example of how social networks may be used to generate narratives. While the networks in the preceding section summarize character interactions, the networks that follow produce interactions. Descriptive and generative networks may at first appear quite different, but I will relate them by showing how structural balance networks produce event sequences that can then be converted back into descriptive sociograms analogous to those shown above. The direct connection will be established towards the end of this section.

#### 3.1 Background: Structural Balance Model

The model I will describe is based on ideas from structural balance theory, also known as social balance theory. SBT was originated in the mid-1940s by Fritz Heider, who studied patterns of belief coherence in individual psychology [11]. In the mid-1950s, Cartwright and Harary generalized Heider's theory of coherence and applied it to social relations, representing



■ **Figure 2** (a) Local triad stability rules. (b) Emergent globally stable network patterns.

stable and unstable configurations with basic graph theory [6]. SBT has since become a sub-branch of social network theory.

Consider a set of nodes representing, for example, people or countries. Each node may be joined to each other node by an edge, which represents their relationship. If two nodes are joined, they are either (1) friends or (2) enemies. The fundamental unit of analysis in SBT is a triad of three mutually linked nodes. A triad is considered unstable if there is social pressure to change one of the relationship links. It is considered stable if there is no social pressure to change.

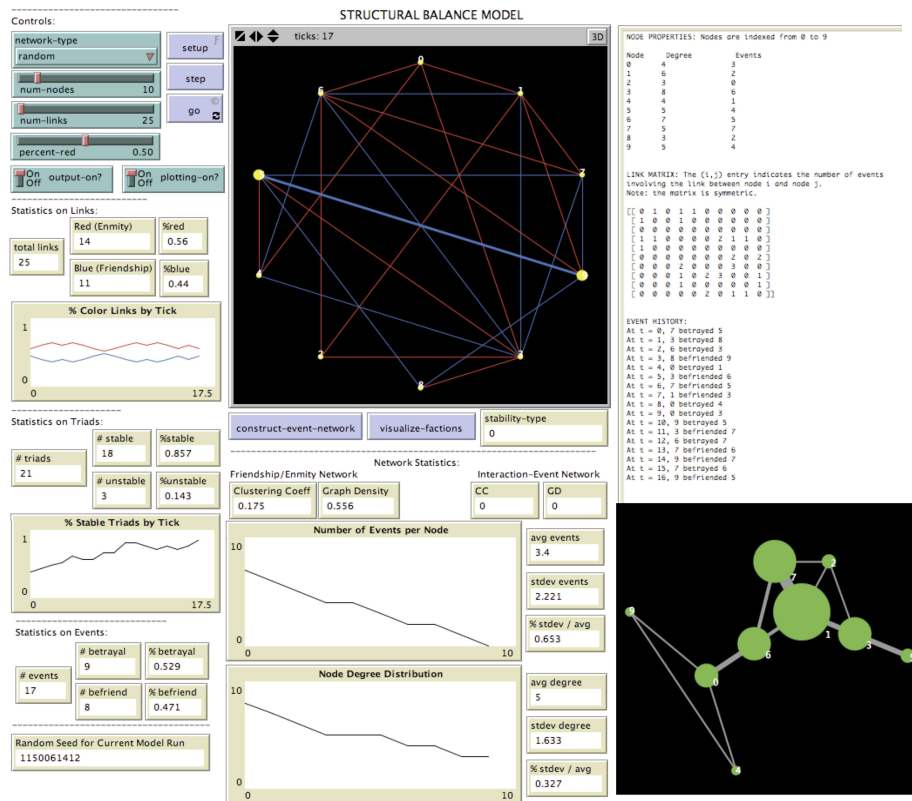
Let (+) represent friendship and (-) represent enmity. There are several possible configurations:

1. (+)(+)(+): If all 3 nodes are friends / allies, the triad is considered stable.
2. (-)(-)(-): If all 3 nodes are enemies, the triad is unstable, since two nodes have an incentive to ally against the third (thereby becoming friends with each other).
3. (+)(+)(-) or (+)(-)(+) or (-)(+)(+): If one node is friends with two that are enemies with one another, it will be pressured to pick a side, and therefore the triad is unstable.
4. (+)(-)(-) or (-)(+)(-) or (-)(-)(+): If two nodes are friends with each other and both are enemies against a third, the triad is stable.

The rule for stability can be summarized as follows: a triad is stable if the multiplicative product of the signs is positive [6]. The stability of the various triads conforms to the following simplified social principles: (1) my friend's friend is my friend; (2) my friend's enemy is my enemy; (3) my enemy's friend is my enemy; (4) my enemy's enemy is my friend.

Note that changing any single link in an unstable triad will make it stable: (-)(-)(-) becomes any cyclical permutation of (-)(-)(+); (+)(+)(-) becomes either (+)(+)(+) or any cyclical permutation of (-)(-)(+). Likewise, changing any link in a stable triad will make it unstable: (+)(+)(+) becomes any cyclical permutation of (-)(+)(+); (-)(-)(+) becomes either (-)(-)(-) or any cyclical permutation (-)(+)(+). Local triad stability rules are illustrated in figure 2, part (a).

The stability of three mutually connected nodes is easy enough to evaluate, but the complexity increases as nodes are added to create larger graphs with many interdependent

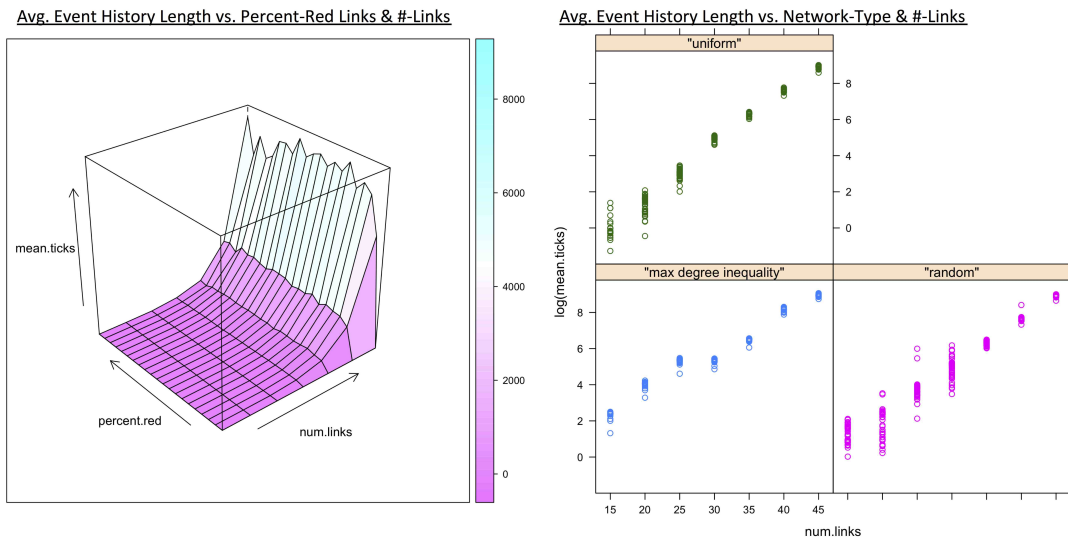


■ **Figure 3** Synopsis of Model Run: (i) an unstable SBT network is constructed with user-specified number of nodes, number of links, and % red (enmity) vs. blue (friendship) links; (ii) as the model runs, link colors change generating an event history; (iii) the model halts when the percentage of stable-triads is 100%; (iv) a character-interaction network is generated from events between nodes.

triads. Nevertheless, global patterns emerge from the local interactions (see figure 2, part (b)). One such pattern is social mitosis: it can be proven that there are only two ways for a complete graph, i.e., one with no missing edges, to be structurally balanced: (1) everyone is friends (universal harmony); or (2) there are two factions of friends with total enmity between them (bi-polar factions).<sup>4</sup> For an incomplete graph, two more outcomes are possible: (3) nodes divide into three or more groups with total enmity between them (multi-polar factions); (4) some nodes are enemies but no factions form (mixed outcome).<sup>5</sup> While the general properties of the equilibrium state of any graph are deterministic, the dynamic process by which that graph reaches an equilibrium is not. This is what makes it interesting and useful as a narrative generation mechanism.

<sup>4</sup> For a simple proof of this theorem, see [7, chapter 5].

<sup>5</sup> A complete graph with  $n$  nodes, has  $nC_2 = n(n-1)/2$  edges, each of which can be in 2 states, (+) or (-); thus, there are  $2^{n(n-1)/2}$  states for the network. It can be shown that  $2^n - 1$  of these are stable outcomes. This corresponds to the number of ways to divide a group with  $n$  members into two factions of size  $m$  and  $(n-m)$ . The non-polarized solution ("universal harmony") is simply the trivial solution where  $m = 0$ . An incomplete graph has more stable configurations since multi-polar and mixed outcomes are permitted.



\* Data shown is based on 88,200 runs of the model – Averages are over 200 runs per input parameters configuration

■ **Figure 4** The length of the “event history”, measured by the mean ticks to reach global stability, is affected by the SBT network’s topology and number of links and the percentage of friendship vs. enmity ties.

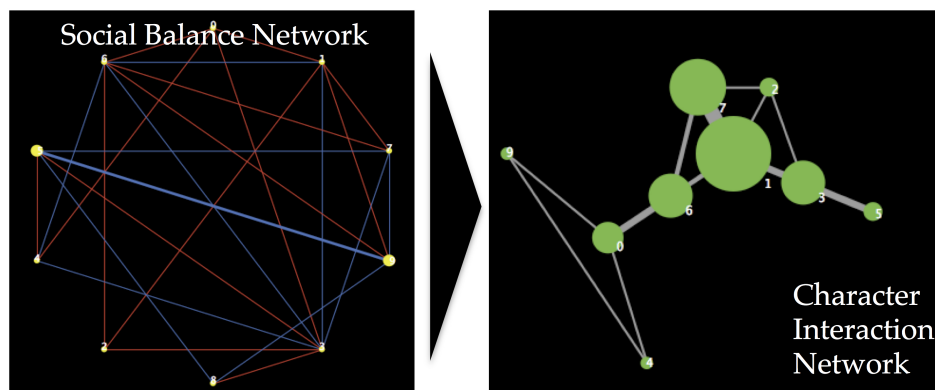
### 3.2 Model Implementation

The next several pages describe a version of the structural balance model that I have implemented in NetLogo, an IDE for agent-based modeling; see figure 3 for the synopsis of a model run. This is not the first computer simulation of structural balance dynamics (see [12, 13, 24] for alternative implementations). The crucial difference is that my focus is not on structural balance in its own right, but rather on motivating a series of observations about the narrative generating potential of social-network-based simulations. Towards this end, my emphasis is on the proto-narratives generated by the model’s dynamics, which are captured by the event history, node history, and relationship-link history discussed below.

At set-up, the user specifies the number of nodes, the number of links, the percentage of links that will be enmity, indicated in red, as opposed to friendship, indicated in blue, and the network’s degree distribution, which may be uniform, random, or maximally unequal. With each time step, the model’s algorithm checks whether there are any unstable triads. If so, the algorithm randomly selects one of the unstable triads and randomly changes one of its links from red to blue or from blue to red. Changing a link’s color stabilizes the selected triad, but may inadvertently destabilize other triads. The model continues stepping forward in time until all triads in the graph have been made stable.<sup>6</sup>

As it runs, the model generates several types of output. First, it produces global network statistics, such as graph density and clustering coefficient. Since clustering coefficient measures

<sup>6</sup> As noted in footnote 5, an  $n$ -node complete graph has  $2^n - 1$  stable outcomes. Because the simple algorithm implemented here proceeds through the random selection of unstable triads and the random flipping of links, there is a non-zero probability of transition between any two graph states. Therefore, the algorithm will halt in finite time. In alternative implementations, this is not necessarily so. For example, if we require that links only be flipped if doing so will immediately increase the number of stable triads, then it is possible for the graph to reach a “jammed state.” For a discussion of such results, see [2].



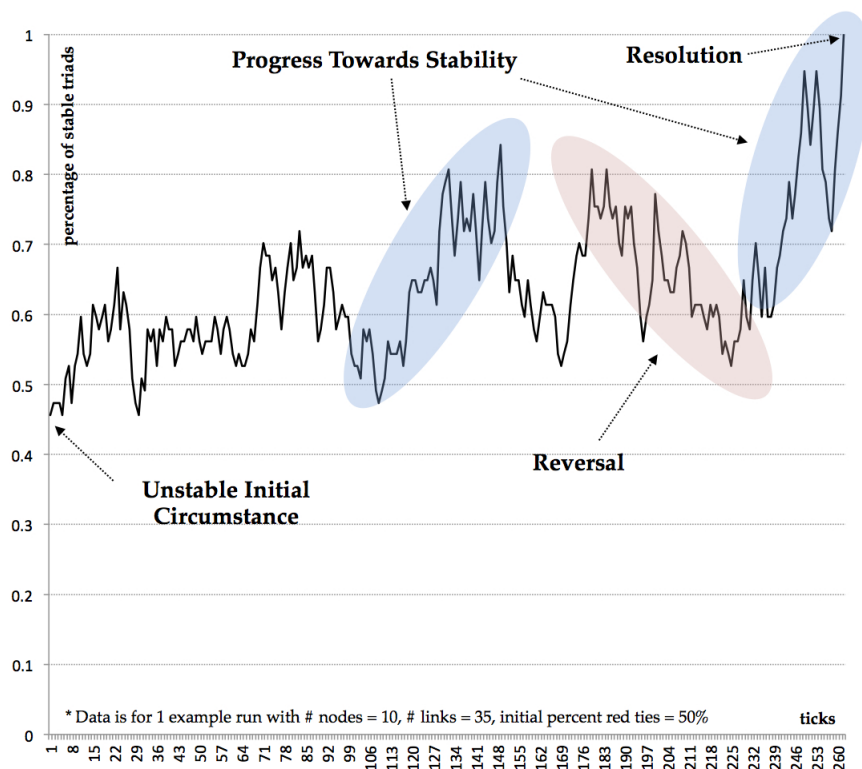
■ **Figure 5** The structural balance network generates character interaction events via link-switchings. The number of events between each pair of characters is represented in a separate character-interaction network.

the prevalence of complete triads, the greater its value, the more complex the structural balancing problem and the more time-steps on average required to reach stability. Second, the model tracks link and triad statistics. These include: (1) number and percentage of friendship vs. enmity ties and (2) number and percentage of stable vs. unstable triads. The program halts when the percentage of stable triads equals 100%. These metrics merely provide basic information about the state of the network. Of greater relevance for narrative generation are the outputs involving events, nodes, and relationships.

An “event” is defined as a change in link color. There are two types of events: (1) befriending: when a red link changes to blue, meaning that the two end-nodes have changed from enemies to friends; (2) betrayal: when a blue link changes to red, meaning that the two end-nodes have changed from friends to enemies. One event occurs each time step until the network reaches global stability. Each event is logged in the event history and is listed as “At  $t = T$ , node  $X$  befriended / betrayed node  $Y$ .” As the model runs, it produces a simple proto-narrative, represented by the list of events that has occurred up to the current time step. This proto-narrative is akin to the “proto-histories” that Robert Axtell generates with the Sugarscape model.

The network topology constitutes a rudimentary setting representing social space rather than physical space. Like the setting of a novel, the geometric configuration of nodes and links defines the environment in which character interaction-events will unfold. Different settings engender different event sequences. The degree distribution, representing how equal vs. unequal the initial allocation of social ties is, is a key topological feature. The model has three settings: (1) uniform degree distribution, (2) random, and (3) maximum degree inequality. Maximum inequality networks are more centralized and have higher clustering coefficients given the same number of links: because the structural balancing problem is more complex, the event history is longer on average for these networks.

Nodes may be thought of as rudimentary characters. Like characters, they have basic descriptive attributes including their degree, initial number of friends and enemies, and location in the network’s topology. Nodes undergo a simple version of “character development”. As the model runs, each node accumulates a personal history consisting of the link-switching events in which it has been involved. Levels of development vary. Some character-nodes are important to the proto-narrative and are involved in many events, while others are marginal. As the model runs, it draws two distributions, both shown in figure 3: (1) the

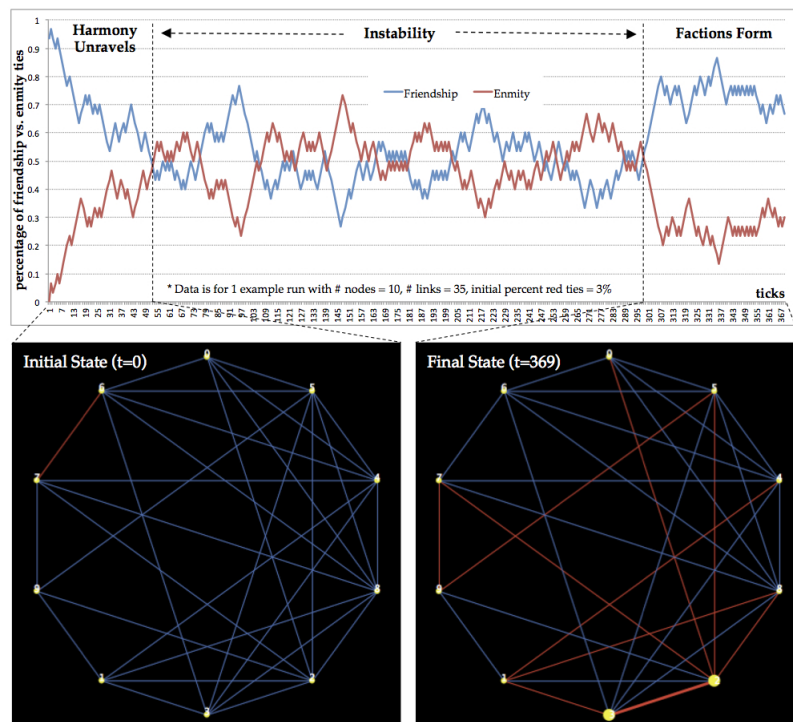


■ **Figure 6** Example run showing percentage of stable triads over time.

degree distribution of the nodes at set-up, and (2) the time-evolving event distribution, showing how skewed the history of the model has been towards particular node-characters. These distributions are imperfectly correlated. High degree nodes, called “hubs”, generally figure in more events, however, it is theoretically possible to have hubs that are embedded in only stable triads: such nodes are central to the network, but peripheral to its narrative of development.

Link-switchings constitute rudimentary character interactions and are designated as either “befriending” or “betrayal”. Just as each node in the structural balance network has a history, so does each relationship-link. Some relationships are active and tumultuous, with many oscillations between friendship and enmity, while others are uneventful. The history of each relationship is stored in an adjacency matrix where the  $(i, j)$  entry tracks the number of events between node-characters  $i$  and  $j$ . It can be visualized as a separate character-interaction network. Figure 5 shows an example. It is important to distinguish between the social balance network, which generates character interactions, and the character interaction network, which summarizes them after the fact. Consistent with White’s concept of “netdom switchings”, as links in the structural balance network switch between friendship and enmity domains, they build up story-ties in the character interaction network. The more domain switchings in the SBT model, the stronger the tie formed. The character interaction network is comparable to the novelistic networks shown in the first half of this paper, which also summarize character interactions. The SBT and character interaction networks may have significant topological differences: in the example above, the character interaction network is more centralized and has a lower clustering coefficient and graph density than the structural balance network that generated it.



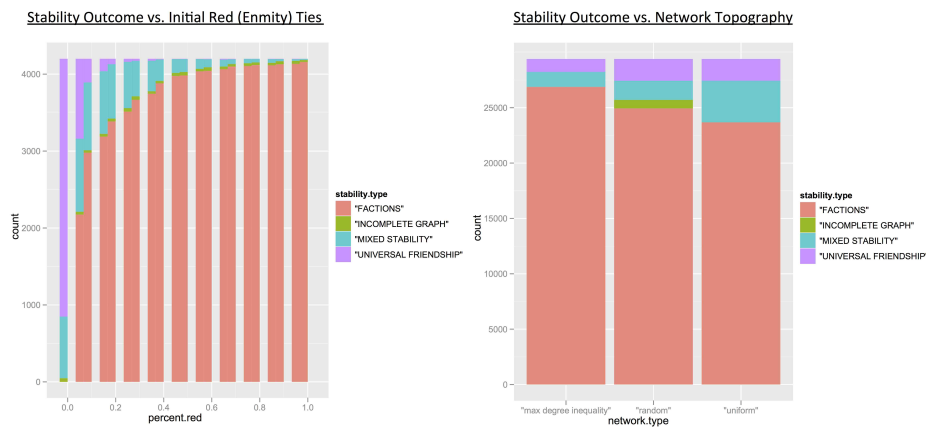


■ **Figure 7** (a) Example run showing percentage of friendship (blue) vs. enmity (red) ties over time. (b) Initial and final SBT network.

Lastly, the model's progression from instability to stability provides both a rudimentary narrative arc and sense of closure. To paraphrase Aristotle's *Poetics*, a narrative begins when an initially stable situation is disturbed by an inciting incident. The resulting disequilibrium constitutes the central problem of the narrative, towards which all actions aim according to Aristotle's principle of unity. The narrative ends when the problem is resolved, providing a sense of closure through the establishment of a new equilibrium.

The SBT simulation conforms to the Aristotelian structure, telling the simple but meaningful story of how a community journeys from an initially unstable configuration to a stable configuration. It possesses a clear beginning, middle, and end and achieves narrative closure through the establishment of a structurally balanced equilibrium. Each event either advances the proto-narrative towards resolution by increasing the percentage of stable triads or constitutes a reversal by decreasing the percentage of stable triads.

The SBT dynamics adhere most closely to an Aristotelian paradigm when we begin the simulation from a state only slightly perturbed from equilibrium by, for example, introducing a single friendship link between two enemy factions or a single enmity link into a network of universal friendship. These initial conditions have obvious analogues in classical narrative. The former roughly corresponds to the inciting incident in a drama such as *Romeo & Juliet*, in which members of rival factions fall in love, while the latter roughly corresponds to the inciting incident in a tragedy such as *Julius Caesar*, in which an act of betrayal between friends tears a community apart. Once disrupted, there are two ways to restore stability: (1) the disturbing link can be extinguished or forced back into conformity as in *Romeo & Juliet*; or (2) the old social structure can be completely unraveled and a new equilibrium established, as in *Julius Caesar*. The latter case is pictured in figure 7. At  $t = 0$ , the network consists



■ **Figure 8** Story ending, represented by stability outcome, is affected by network topology and percentage of friendship vs. enmity ties.

of only friendship ties except for one enmity link. Universal harmony unravels in the first phase of the run—what we might call “act one”—evidenced by the rapid fall in friendship links and rise in enmity links. This phase ends when the percentage of friendship and enmity ties is equalized, indicating the original social structure has completely collapsed. A middle phase of instability and flux follows. Finally, a new equilibrium structure begins to form consisting of two polarized factions. The model terminates when social mitosis is complete. The sequence of events is reminiscent of Harrison White’s assertion that “a network can be traced as similar stories appear across a spread of dyads. The “story” that spreads in this case is one of mounting enmity—an initial act of betrayal ripples outward, cleaving the network.

While the model will eventually find an ending represented by a stable outcome, when and what type of ending are indeterminate. There are three possibilities for an incomplete graph: (1) universal harmony, or what we might consider a “happy ending”; (2) polarized factions, or what we might consider an “unhappy ending”; (3) or a mixed outcome. The indeterminacy of the ending provides a rudimentary version of narrative suspense. Figure 8 shows the effect of different input parameters on the ending of the proto-narrative.

## 4 Conclusion

Lest the “proto-narrative” produced by this structural balance simulation strike us as overly simplistic, it is worth observing that the acts of betraying and befriending and the reconfiguration of social allegiances are the core events of many classical and contemporary social dramas, ranging from French court novels such as *Le Princesse de Clèves* and *Les Liaisons dangereuses* to contemporary soap operas such as *Gossip Girl*. In a recent paper entitled “Facebook for Vikings”, folklorist Timothy Tangherlini argues that the plot structures of Scandinavian story cycles can be understood in terms of shifting alliances and enmities consistent with SBT:

In a great deal of saga scholarship there is an understandable emphasis on understanding enmity, with friendship acting as a powerful counter force (Byock 1982; Miller 1983 and 1990). Network analysis allows one to consider friendly interactions and antagonistic relationships both as individual features of the saga narrative and in concert with each other... Perhaps one of the most complicated aspects of social

interaction considered in the sagas is the selection of friends and its inverse, the selection of enemies. [23]

Tangherlini analyzes the famous “Höfuðlausn” or head ransom episode in *Egil’s Saga* in terms of interdependent triads between four characters—Egil, Eirik, Arinbjorn, and Gunnhild. All friendship and enmity ties are determined prior to the episode except for the relationship between Arinbjorn and Gunnhild. Tangherlini argues that the dramatic arc of the head ransom episode consists in the determination of the Arinbjorn-Gunnhild relationship and the reconfiguring of the Egil-Eirik relationship based on the stability requirements of SBT.<sup>7</sup> Tangherlini’s approach is confirmed by a recent study of ‘mythological networks,’ in which MacCarron and Kenna find that several ancient and medieval epics, including *Beowulf* and *The Iliad*, obey structural balance rules [15].

Studies such as Tangherlini’s demonstrate that structural balance theory has value as a descriptive model of socially complex narratives, but it has perhaps even greater potential as a generative mechanism that could be used for new story creation.

Finding realistic but tractable story generation mechanisms is an ongoing challenge for artificial intelligence researchers working on narrative. Most story generators rely on either (a) corpora of pre-existing stories (e.g., MEXICA [21]), or (b) story grammars. Researchers in this area are now attempting to expand the suite of generative mechanisms to include games as well as crowdsourcing [14]. In a recent paper, Pablo Gervás argues for the value of chess as a narrative generation mechanism:

Chess provides a finite set of characters (pieces), a schematical representation of space (the board), and time (progressive turns), and a very restricted set of possible actions. Yet it also allows very elementary interpretations of game situations in terms of human concepts such as danger, threat, conflict, death, survival, victory or defeat, which can be seen as interesting building blocks for story construction. [9]

There is a related body of work that makes use of sports game statistics to generate simple narratives akin to newspaper articles [1]. Like chess and sports, dynamic network models such as structural balance could provide a narrative generation mechanism to complement corpus analysis. They possess the added advantage of supporting social behaviors that are more complex than direct competition or physical conflict.

Most promisingly, there is growing emphasis in the interactive narrative community on story-worlds that incorporate complex and nuanced social dynamics. Notable examples include *The Sims* and Michael Mateas’ experimental game *Façade* [16]. UC Santa Cruz’s *Prom Week*—in which players manipulate the social interactions between high schoolers in the week leading up to prom—is perhaps the most sophisticated example of an emerging

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<sup>7</sup> Tangherlini’s study also provides a useful set of benchmarks for calibrating the SBT model. In *Egil’s Saga*, Tangherlini counts a total of 316 friendship interactions and 158 enmity interactions, of which 61 are “lethal” and 97 are “non-lethal” (a roughly 2:1 ratio of friendship to enmity events). This total of 474 interactions is spread across 200 “saga actants.” The ratio of events to characters that Tangherlini finds is low compared to that generated by the SBT model I have outlined. This is likely due to several factors. First, the graph for *Egil’s Saga* is highly incomplete, with very low graph density. As shown in figure 4, the length of the “event history” is very sensitive to the number of links in the network: relatively complete graphs take exponentially longer to resolve than relatively incomplete graphs. Second, and perhaps more importantly, there is a key difference that should be drawn between story-events and discourse-events. Our model generates story-events, not all of which need ultimately be rendered narratable in the final text. The events in the discourse of *Egil’s Saga* have been selected from underlying story-events that are deemed worthy of narration because, for example, they involve specific characters of interest, such as Egil.

category of “social games” that incorporate sociological and psychological models into AI to ‘gamify’ social experience. *Prom Week* makes explicit use of social networks and claims to have more than five thousand social rules guiding character behavior, including “if someone is mean to me, then someone else does something mean to them, I’m more likely to want to date that person”. [17] This enemy-of-my-enemy-is-my-friend rule could be integrated easily with structural balance dynamics. As “social games” gain traction in interactive narrative, generative network models such as the one I have outlined on structural balance will have increasing value.

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