

Extraction and Analysis of Fictional Character Networks

Vincent Labatut

Laboratoire Informatique d'Avignon, Avignon Université – LIA EA 4128
vincent.labatut@univ-avignon.fr

Workshop on Computational Methods in the Humanities
COMHUM 2022 – 9 June 2022



Outline

- 1 Introduction
- 2 Network Extraction
- 3 Descriptive Analysis
- 4 Applications
- 5 Conclusion

Introduction

Terminology I

Definitions based on Bordwell and Thompson's work [BT93]:

- 1 **Narrative**: report of events (telling a story)
 - **Communication** means: text, speech, images, music, gestures...
 - **Forms**: fables, tales, novels, plays, movies, TV series, video games, cartoons, comics...
- 2 **Plot**: collection of events **explicitly** reported by the narrative
 - Often ordered to form a chronological and/or causal chain

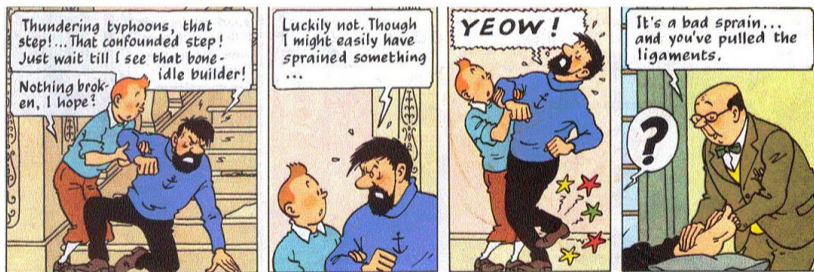


Tintin #21, *The Castafiore Emerald*, by Hergé, 1963, published by Casterman (FR) / Methuen (EN).

Introduction

Terminology II

- ③ **Story**: all the plot events, plus those imagined or inferred by the audience
- Based on both the plot and a number of contextual factors
 - Example: audience interpolates ellipsed events



- Summary:
 - Plot = **What** is told
 - Narrative = **How** it is told
 - Story = what the audience **understands**

Introduction

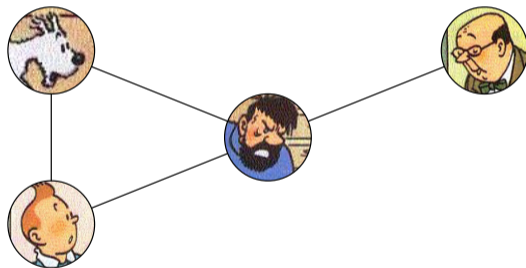
Plot Modeling

- **Plot** as the most important aspect of the narrative
 - **models**: scene transition graphs [YYL96], narrative structure graphs [Jun+04], and others
- Why character networks?
 - **Characters** considered as agents that advance the plot through their actions [MP16]
 - Focus on **interactions** between characters, the backbone of the narrative [Pra+16]
 - Graphs are the **natural** modeling paradigm for interactions
 - Allow **formalizing** [Mor11] certain narrative studies concepts [Wol03]

Introduction

Notion of Character Network

- What is a character network, exactly?
 - **Vertices**: characters, groups of characters
 - **Edges**: interactions or relations between characters



- Exact form depends on:
 - Available **data** (form of the narrative?)
 - Extraction **tool** (ability/reliability?)
 - Nature of the **application** (informational needs?)

Introduction

Usage of Character Networks

Main types of uses in the literature:

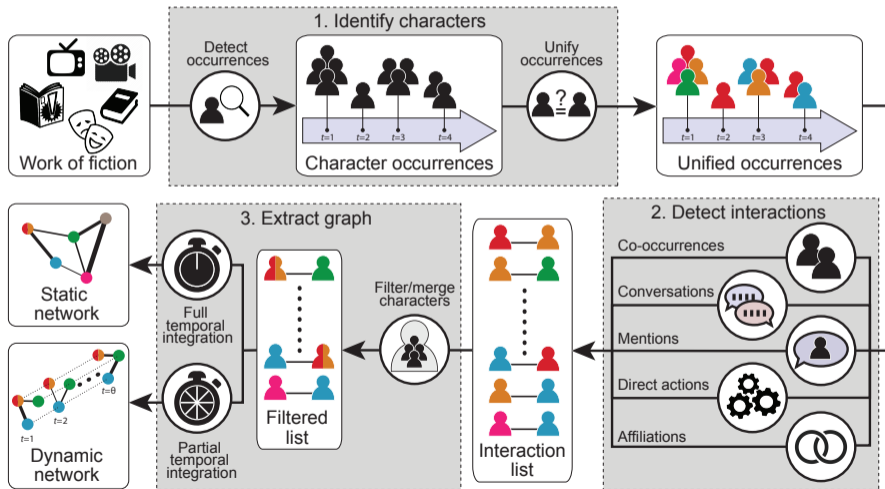
- **Narrative Studies**
 - Manual extraction, small corpora
 - Visualization, detection of important characters, assessment of literary theories, comparative analysis
- **Complex systems**
 - Also manual extraction and small corpora
 - Descriptive analysis, comparison of topological properties with real-world social networks, random models, or other fictions
- **Computer Science / Artificial Intelligence**
 - Automatic extraction, large corpora
 - Extraction automation, network used as a plot model to tackle higher level problems (summarization, recommendation...)
- **Mainstream** works, mainly for visualization
- **Benchmarking** graph-related computer science methods

Section 2

Network Extraction

Network Extraction

Overview of the Extraction Process



Network Extraction

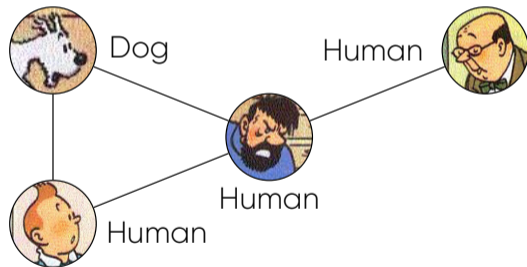
Narrative-Specific Tasks

- (Unstructured) **text**:
 - Occurrence detection: exact matching, NER
 - Occurrence unification: coreference resolution, alias resolution
 - Interaction detection: utterance detection, utterance attribution, SVO triplets detection & classification
- **Video** stream:
 - Occurrence detection: face detection & tracking
 - Occurrence unification: face track clustering
 - Name identification: face name matching
 - Interaction detection: scene segmentation, lip motion detection, H-H interaction detection
- **Audio** stream:
 - Occurrence detection: speaker segmentation
 - Occurrence unification: speaker clustering or diarization
 - Name identification: speaker identification
- **Hybrid** approaches: combine audio, video, and text

Network Extraction

Graph Construction

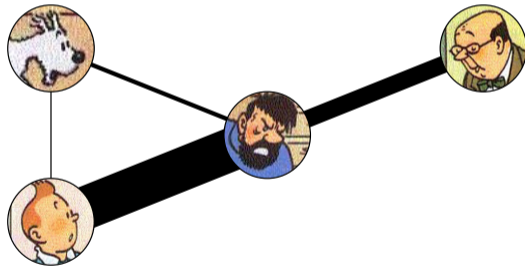
- Character **type**
 - Ex. gender, race, abilities...
 - **Attributed** graph
- Interaction **intensity/strength**
 - Ex. distance, duration, nature...
 - **Weighted** graph
- Interaction **laterality**: uni- vs. bilateral
 - Ex. speaker/addressee
 - **Directed** graph
- Interaction **polarity**
 - friendly vs. hostile
 - **Signed** graph
- Interaction semantic **category**
 - Ex. *murder* vs. *other* (GoT)
 - **Multiplex** graph



Network Extraction

Graph Construction

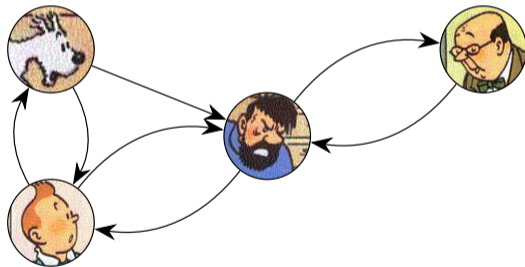
- Character **type**
 - Ex. gender, race, abilities...
 - **Attributed** graph
- Interaction **intensity/strength**
 - Ex. distance, duration, nature...
 - **Weighted** graph
- Interaction **laterality**: uni- vs. bilateral
 - Ex. speaker/addressee
 - **Directed** graph
- Interaction **polarity**
 - friendly vs. hostile
 - **Signed** graph
- Interaction semantic **category**
 - Ex. *murder* vs. *other* (GoT)
 - **Multiplex** graph



Network Extraction

Graph Construction

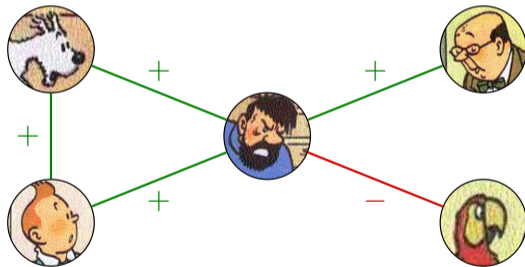
- Character **type**
 - Ex. gender, race, abilities...
 - **Attributed** graph
- Interaction **intensity/strength**
 - Ex. distance, duration, nature...
 - **Weighted** graph
- Interaction **laterality**: uni- vs. bilateral
 - Ex. speaker/addressee
 - **Directed** graph
- Interaction **polarity**
 - friendly vs. hostile
 - **Signed** graph
- Interaction semantic **category**
 - Ex. *murder* vs. *other* (GoT)
 - **Multiplex** graph



Network Extraction

Graph Construction

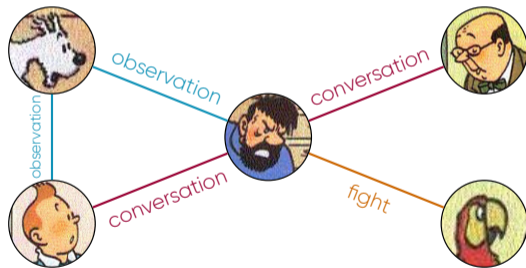
- Character **type**
 - Ex. gender, race, abilities...
 - **Attributed** graph
- Interaction **intensity/strength**
 - Ex. distance, duration, nature...
 - **Weighted** graph
- Interaction **laterality**: uni- vs. bilateral
 - Ex. speaker/addressee
 - **Directed** graph
- Interaction **polarity**
 - friendly vs. hostile
 - **Signed** graph
- Interaction semantic **category**
 - Ex. *murder* vs. *other* (GoT)
 - **Multiplex** graph



Network Extraction

Graph Construction

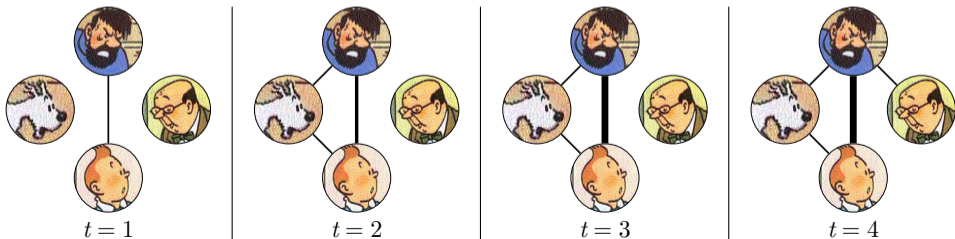
- Character **type**
 - Ex. gender, race, abilities...
 - **Attributed** graph
- Interaction **intensity/strength**
 - Ex. distance, duration, nature...
 - **Weighted** graph
- Interaction **laterality**: uni- vs. bilateral
 - Ex. speaker/addressee
 - **Directed** graph
- Interaction **polarity**
 - friendly vs. hostile
 - **Signed** graph
- Interaction semantic **category**
 - Ex. *murder* vs. *other* (GoT)
 - **Multiplex** graph



Network Extraction

Dynamics of the Narrative

- **Temporal integration**: aggregate interactions over a period of time
 - Count, correlation, average, sum
 - Model fit to the sequence of interactions
- **Static network**: integration over the **whole** narrative
 - Information **loss**: chronology of interactions
- **Dynamic network**: **piece**-wise integration
 - **Fixed**-sized sliding window vs. **event**-based approaches
 - Cumulative vs. instantaneous network



Section 3

Descriptive Analysis

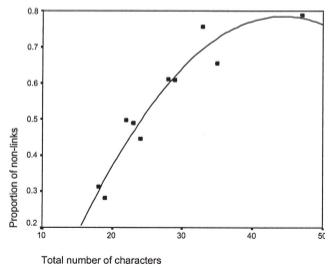
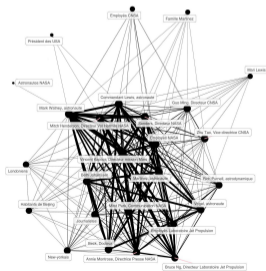
Descriptive Analysis Overview

- Many tools designed to study **general** complex networks:
 - **Relevance** to character networks?
 - Specific **interpretation**?
- **Main** tools used in the character network literature:
 - Graph density
 - Edge weights
 - Degree & Strength
 - Geodesic distance
 - Betweenness, Closeness
 - Transitivity
 - Modular structure
 - Articulation points & Vitality
 - Vertex attributes
 - Spectral centrality
 - k -cores
 - Cyclic Coefficient

Descriptive Analysis

Graph Density

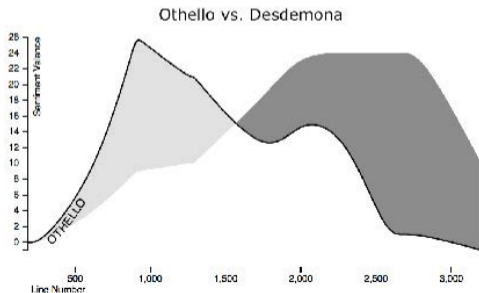
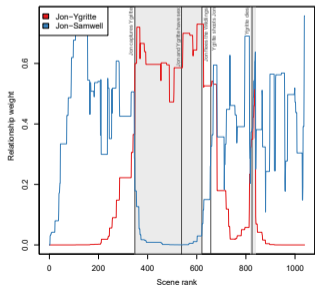
- **Density**: proportion of existing edges
 - Directly tied to certain aspects of the narrative
 - Dense & centerless → *behind closed doors* story type [RT17]
 - Density w.r.t. number of characters
 - Decrease → writer limits characters in subplots [SND03; SH05]
 - Sparse & moderate transitivity → social dissociation [Sac12]
 - Used as a stylistic feature to distinguish playwrights [VG08]



Descriptive Analysis

Edge Weights

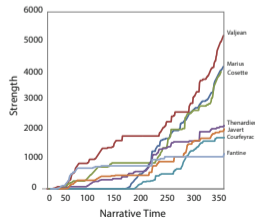
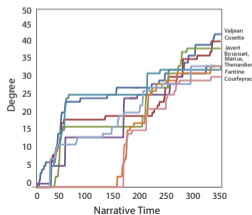
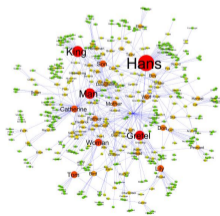
- **Weights:** intensity of the relation
 - Used comparatively: w.r.t. other characters; or w.r.t. time
 - Weak vs. strong edges → Major–minor vs. Major–Major [Sac12]
 - Power law distribution
 - Reveals the artificiality of the collaborations [Gle07]
 - Focus on top-2 edges to assess level of plot focus [SKG13]
- Evolution: sudden changes → important events [Bos+16; NB13]



Descriptive Analysis

Degree & Strength I

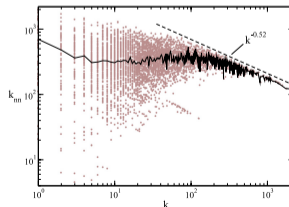
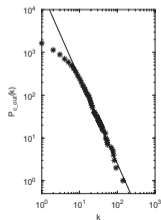
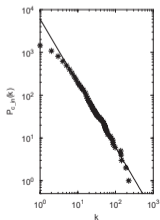
- **Degree**: number of (un)directed edges attached to a vertex
- **Strength**: weighted generalization (sum of edge weights)
 - Hubs → protagonists [SC13], antagonists [MCC18], but also narrators [Roc14], authority figures [SC13]
- **Directed** edges: incoming vs. outgoing degree/strength
 - Ex. Incoming = in charge (Zeus), outgoing = force for change (Herakles) [SC13]
- **Evolution**: passing of power [Roc14], change of focus [MP16]



Descriptive Analysis

Degree & Strength II

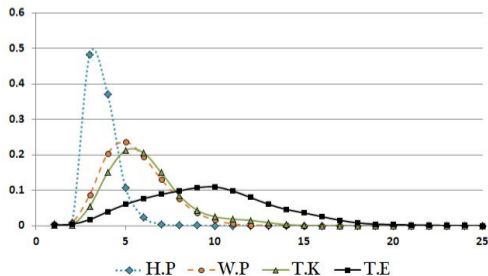
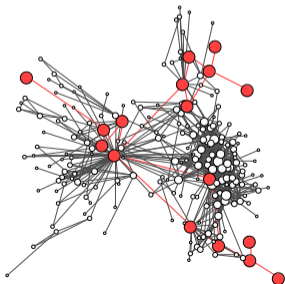
- **Distribution:**
 - (truncated) **power law** when dominated by one or a few chars
 - **Scale-free** networks are frequent in other domains
 - But other distributions observed (due to filtering?)
- **Assortativity:** degree **correlation** between attached vertices
 - Character networks generally **disassortative** [MK12]
 - Unlike **real-world** social networks, which are **assortative**
 - Edges connect a few frequent **protagonists** to many **minor** passer-by characters
 - Protagonists not as much connected, same for minor characters



Descriptive Analysis

Geodesic Distance

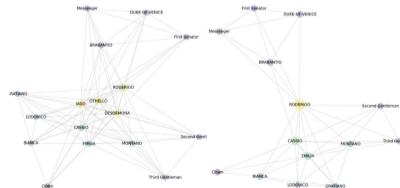
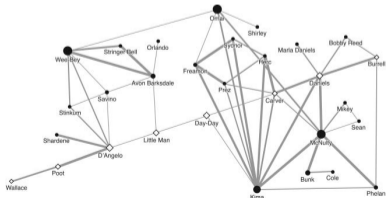
- **Geodesic distance**: length of the shortest path (on the graph)
- **Small-world**: requires relatively small average distance or logarithmic growth (+transitivity) [WS98]
- Diameter & average distance: **compactness** of the story
- Small value: narrative proximity between characters [Roc14]
- Large diameter & transitivity: episodic narrative [Sac14]



Descriptive Analysis

Betweenness Centrality

- **Betweenness**: number of shortest paths going through the considered vertex [Fre77]
 - Central vertex → character acting as a narrative bridge, connecting separate parts of the plot [Bol+13]
 - Also role of messenger, generally towards supporting characters [MCC18]
 - These characters are not necessarily noticed by the audience [Bol+13]
 - Protagonists are generally central in terms of betweenness, but not only [SC13]
 - Average, centralization → focus of the plot on protagonists



Descriptive Analysis

Closeness Centrality

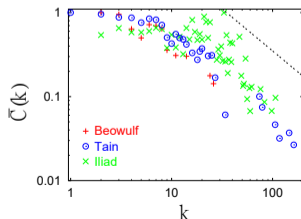
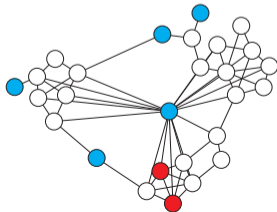
- **Closeness**: the reciprocal of the average (or total) distance between the considered vertex and the rest of the network [Bav50]
 - Measures how close a character is from all the others, in terms of character-space
 - Used to identify the network center [AMR02]
 - Identify important minor characters involved in significant subplots [Roc14]
 - **Harmonic** version for disconnected networks [BV14]
- Alternative: **eccentricity** [Har69], max instead of average



Descriptive Analysis

Transitivity

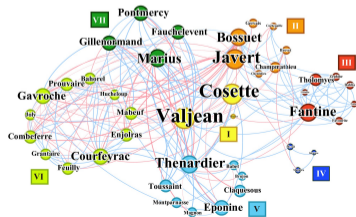
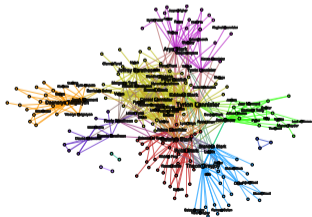
- **Transitivity** (a.k.a. Clustering Coefficient): ratio of closed triads to open triads, counted locally or globally
 - Small-world property requires high transitivity [WS98]
 - High in many character networks [AMR02; SND03; MK12; AS14]
 - High global \rightarrow presence of cliquish groups of characters appearing recurrently together [SND03]
 - Low local \rightarrow character belonging to several such groups [SH05]
 - Antagonists and their supporters tend to be more tightly-knit [MCC18]
 - Generally strong inverse correlation between degree and transitivity [Gle07; CK07; MK12] \rightarrow hierarchical structure



Descriptive Analysis

Modular Structure

- **Component**: maximal connected subgraph
 - Multiple components are rare in character networks
- **Community**: dense subgraph, loosely connected to the rest of the network [For10]
 - Characters gathered based on spatial and/or temporal criteria [BS16] → Community \approx subplots [Bol+13; KA15]
 - Often built around a local character core [LJ19]
 - Network gets larger → community number increases & community size decreases [Jay+15]
 - Protagonists likely to appear in **several** subplots [MCC18] → **overlapping** communities



Section 4

Applications

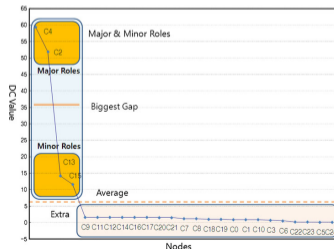
Main **applications** of character networks:

- Many **case studies**
- **Higher-level** problems:
 - Assessment of literary theories
 - Level of realism and Historicity
 - Role detection
 - Classification of fiction Works
 - Storyline detection
 - Summarization
 - Plot segmentation
 - Preprocessing improvement
 - Generation of proto-narratives
 - Recommender systems
 - Alignment of narratives
 - Narrative comparison

Applications

Role Detection

- Assign one among several predefined **narrative roles** to each character
 - **Importance**: Major/minor [SH05], +supporting [POJ12]
 - **Polarization**: Protagonist/antagonist [KS17], +importance [JYP13]
 - **Specific**: narrator [Aga+12], cops/gangsters/informants [Pop+15]
- **Methods**:
 - Use vertex topological **measures** (degree/strength, transitivity, betweenness, closeness...) as **features**
 - Thresholding, combination, cluster analysis, classification



Applications

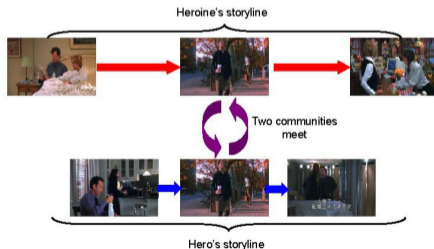
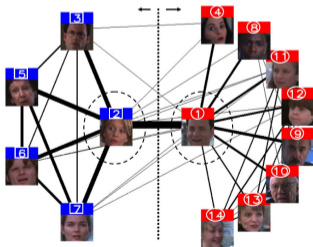
Classification of Fiction Works

- **Task:** leverage the network structure to predict some traits of the work of fiction
 - + **Metadata:** medium, genre, writer, date, length/duration
 - + **Content:** narrator PoV, word frequency, topics...
- **Non-supervised** approaches:
 - Classes of plots: kernel, unicentric, acentric, polycentric [RT17]
 - Cluster similar novels, study uniformity in terms of genre and writer [AS14]
- **Supervised** approaches:
 - Cinema vs. theater; publication year [SKG13]
 - Genre of novels [Het+15], playwright [LYL19]
 - Fiction/Biography/Legend [Hol+19]

Applications

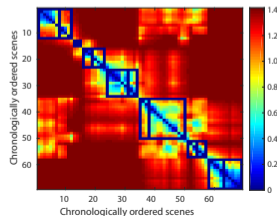
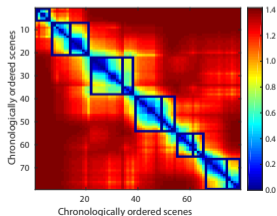
Story Decomposition

- **Storyline detection**: identify multiple intertwined subplots
 - Assumption: each storyline organized around a leading character [WCW07]
 - Methods:
 - 1 Identify important characters and their entourage (communities)
 - 2 Match scenes and communities
 - 3 Multiple matching → point of contact between storylines



Applications Summarization

- **Extractive summary**: combine important scenes picked from the original narrative
 - Ex.: character-focused summary [Bos+19]
 - **Assumption**: important events associated to durable changes in the social environments of concerned characters
 - **Methods**:
 - ① Extract dynamic conversational network using narrative smoothing
 - ② Compute neighborhood similarity matrix
 - ③ Partition sequence of successive neighborhoods
 - ④ Use low level multimedia features to select relevant scenes



Section 5

Conclusion

Conclusion

Perspectives & Open Problems

- Character/interaction identification:
 - Many open problems
 - End-to-end approaches
 - Need fiction-oriented corpora
- Network analysis
 - Experiment with other CN tools (e.g. motifs)
 - Leverage enhanced/dynamics networks
- Applications
 - Experiment with graph embeddings instead of features
 - Trans- and cross-media narratives
 - Generation of narratives

Conclusion

Survey Article & Resources

- Presentation based on a 2019 [survey paper](#) written with X. Bost¹ (better read the extended version)

Extraction and Analysis of Fictional Character Networks: A Survey

VINCENT LABATUT, Laboratoire Informatique d'Avignon – LIA EA 4128
XAVIER BOST, Orkis and Laboratoire Informatique d'Avignon – LIA EA 4128

A *character network* is a graph extracted from a narrative in which vertices represent characters and edges correspond to interactions between them. A number of narrative-related problems can be addressed automatically through the analysis of character networks, such as summarization, classification, or role detection. Character networks are particularly relevant when considering *works of fiction* (e.g., novels, plays, movies, TV series), as their exploitation allows developing information retrieval and recommendation systems. However, works of fiction possess specific properties that make these tasks harder.

This survey aims at presenting and organizing the scientific literature related to the extraction of character

89

- [Online list](#) of character network-related papers² (and other resources), regularly updated

¹V. Labatut and X. Bost. "Extraction and Analysis of Fictional Character Networks: A Survey". In: *ACM Computing Surveys* 52.5 (2019), p. 89. DOI: [10.1145/3344548](https://doi.org/10.1145/3344548). [{hal-02173918}](#) .

²<https://compnet.github.io/CharNetReview/>

Questions?

Section 6

Appendix

Network Extraction

Fiction vs. Non-Fiction

- Why not use methods developed for **non-fiction narratives**? (e.g. biographies, meeting reports, press articles and shows...)

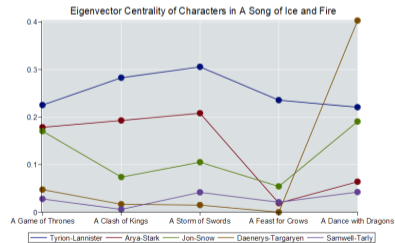
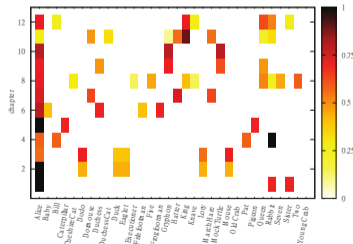
→ **Specific** features of fiction works

- Some make automation **harder**:
 - **Stylistic** differences: ex. literary prose affects NLP tools (e.g. NER, coreference resolution), editing techniques affect scene detection
 - **Uncontrolled** conditions affect multimedia tools (e.g. face and speech recognition)
- Some make it **easier**:
 - **Structure** of the narrative (e.g. scripts)
 - Narrative **conventions** (e.g. film grammar, conversation turns)
 - Fictions are **closed-worlds** (helps alias resolution)

Descriptive Analysis

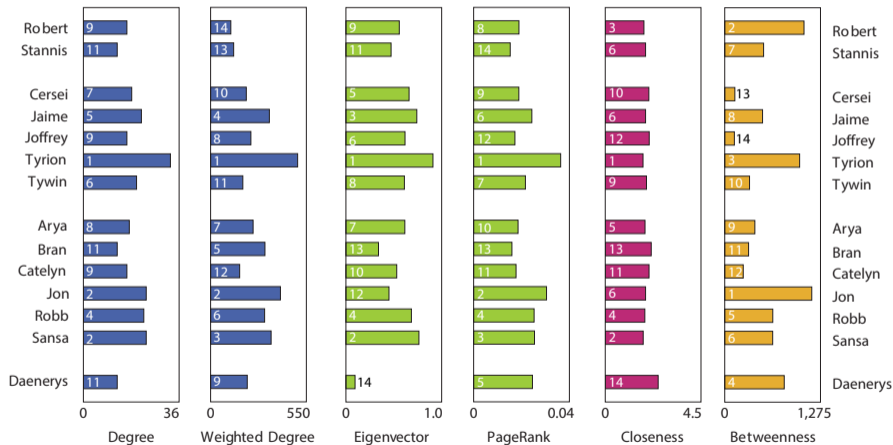
Spectral Centrality

- Family of measures based on the spectrum of the adjacency matrix (or a variant)
 - Most widespread: Eigenvector centrality, generalization of the degree [Bon72]
 - Higher value when vertex embedded in dense community
 - Lower for characters largely connected to peripheral characters [Alg17]
 - Conspirators = high EV but low betweenness in plays [Alg17]
 - Detect hero vs. villain in adversarial movies [DY10]
 - Evolution: describe character trajectory [Pra+16]



Descriptive Analysis

Comparison of Centrality Measures I



Centrality in the network of *Game of Thrones* [BS16]

Descriptive Analysis

Comparison of Centrality Measures II

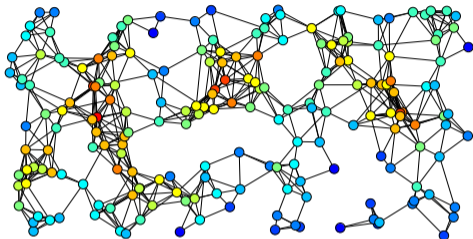
The ten most prominent actors regarding centrality

Rank	Node	Degree	Node	Closeness	Node	Betweenness
1	HT (Hector)	97	HT (Hector)	0.4972	HT (Hector)	0.2100
2	AC (Achilleus)	75	AC (Achilleus)	0.4661	AC (Achilleus)	0.1594
3	AJ (Ajax)	63	AJ (Ajax)	0.4629	ZE (Zeus)	0.1375
4	PA (Patroclus)	61	ME (Menelaus)	0.4486	PA (Patroclus)	0.1280
5	ME (Menelaus)	54	AG (Agamemenon)	0.4479	DI (Diomedes)	0.1036
6	AG (Agamemenon)	54	ID (Idomeneus)	0.4387	AJ (Ajax)	0.0904
7	ZE (Zeus)	52	PA (Patroclus)	0.4373	AG (Agamemnon)	0.0849
8	OD (Odysseus)	50	AE (Aeneas)	0.4341	OD (Odysseus)	0.0798
9	DI (Diomedes)	49	DI (Diomedes)	0.4331	NE (Nestor)	0.0685
10	AL (Antilochus)	45	ZE (Zeus)	0.4331	TU (Teucer)	0.0654

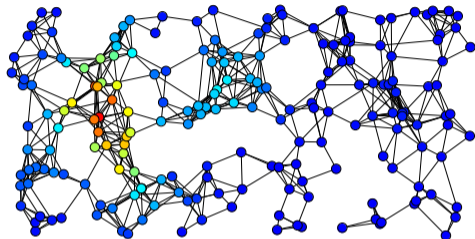
Centrality in the network of *The Iliad* [KNE15]

Descriptive Analysis

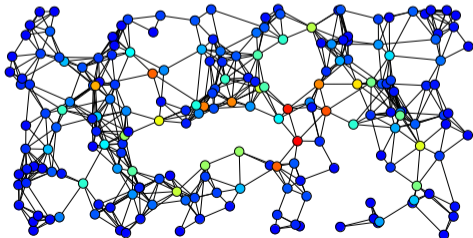
Comparison of Centrality Measures III



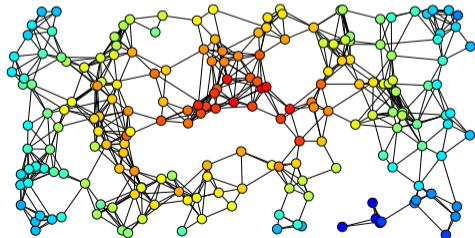
Degree



Eigenvector Centrality



Betweenness Centrality

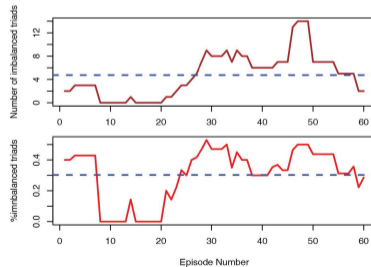
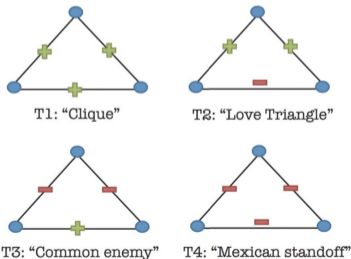


Closeness Centrality

Descriptive Analysis

Structural Balance

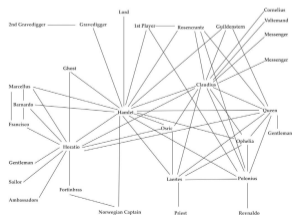
- Structurally balanced triangle: contains exactly 0 or 2 negative edges [CH56]
- Network (im)balance: proportion of (im)balanced triangles in the graph
 - Matches real-world social network balance [Yos+18]...
 - ...or not: GoT much more imbalanced [LA17]
- Evolution: brutal changes reflect narrative phases [Sac12]



Descriptive Analysis

Articulation Points & Vitality

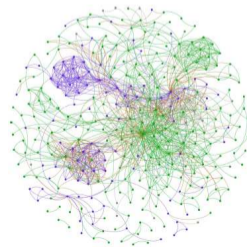
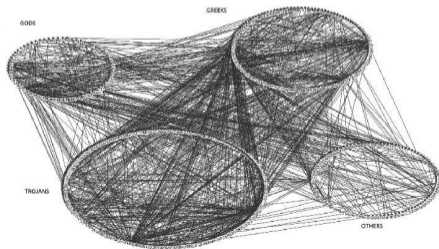
- Importance of a vertex can be assessed depending on how its **removal** affects the network
 - Assumption: important characters bring some form of **stability**
- **Articulation point**: vertex whose removal disconnects the graph
 - Focus on central characters, e.g. in *Hamlet* [Mor11]
 - If disconnection: story relies heavily on concerned characters [MK12]
- **Vitality**: how a graph-related quantity changes when removing a vertex of interest [Kos+05]



Descriptive Analysis

Vertex Attributes

- Prevalence of the attribute modalities in the graph, e.g. occupations in SF [RT17]
- Topological measures computed over the subgraphs induced by each modality, e.g. Trojan net in the *Illiad* [KNE15]
- Assortativity/homophily: correlation between the modalities of connected vertices [New03a]
 - Vikings vs. Irishmen in Irish epic [Yos+18]
 - Adolescent support affected by school year, school house or gender in *Harry Potter*? [BM13]



Applications

Assessment of Literary Theories

Elson *et al.* study the **conversational** networks of 60 19th century British **novels** [EDM10]

- **Hypotheses:**

- h_1 : not possible to show many conversations when there are many characters to consider
 - Inverse correlation between amount of dialogue and network size
- h_1 : that depends on the social setting of the novel
 - More verbal interactions in rural than urban communities

- **Results:**

- Positive correlation between the numbers of characters and utterances, average degree, density → against h_1
- No significant difference between numbers of characters and any tested feature, relative to setting → against h_2

Applications

Level of Realism and Historicity

Do character networks exhibit realistic social interactions?

- **Methods:**

- 1 Describe character networks using standard topological descriptors (degree, distance, transitivity...)
- 2 Compare to real-world measurements

- **Examples:**

- Are **mythological** networks closer to reality or fiction networks? [Mac14]
 - Some network parts are realistic (e.g. *Beowulf* without protagonist)
- Do successful **dramas** have to portray realistic relationships? [SND03]
 - Yes (distances, subgroups) and no (degree distribution) (Shakespeare)
- How do **super-heroes** compare to other types of collaborations? [Gle07]
 - Narrower circles of collaborators (Marvel)

- **Preprocessing improvement**: face clustering [YW14], scene segmentation [Lia+09]
- **Generation of proto-narratives**: sequences of events involving characters, useful to later build stories [Sac12; Sac13; Sac14]
- **Recommendation systems**: compare movie plot based on their dynamic character networks [LJ19]
- **Alignment of narratives**: automatically detecting movie remakes [CSR18]
- **Narrative comparison**: character-based comparison of novels [Els12]

Section 7

References

References I

- [Aga+12] A. Agarwal, A. Corvalan, J. Jensen, and O. Rambow. "Social Network Analysis of Alice In Wonderland". In: *NAACL - Workshop on Computational Linguistics for Literature*. 2012. URL: http://www.cs.columbia.edu/~apoorv/Homepage/Publications_files/naacl2012.pdf.
- [AMR02] R. Alberich, J. Miro-Julia, and F. Rossello. "Marvel Universe looks almost like a real social network". In: *arXiv cond-mat.dis-nn* (2002), cond-mat/0202174. URL: <http://arxiv.org/abs/cond-mat/0202174>.
- [Alg17] M. Algee-Hewitt. "Distributed Character: Quantitative Models of the English Stage, 1550–1900". In: *New Literary History* 48.4 (2017), pp. 751–782. DOI: [10.1353/nlh.2017.0038](https://doi.org/10.1353/nlh.2017.0038).
- [AS15] M. C. Ardanuy and C. Sporleder. "Clustering of novels represented as social networks". In: *Linguistic Issues in Language Technology* 12 (2015). URL: <http://csli-lilt.stanford.edu/ojs/index.php/LiLT/article/view/60>.
- [AS14] M. C. Ardanuy and C. Sporleder. "Structure-based Clustering of Novels". In: *3rd Workshop on Computational Linguistics for Literature*. 2014, pp. 31–39. URL: <http://www.aclweb.org/anthology/W14-0905>.
- [Bav50] A. Bavelas. "Communication patterns in task-oriented groups". In: *Journal of the Acoustical Society of America* 22.6 (1950), pp. 725–730. DOI: [10.1121/1.1906679](https://doi.org/10.1121/1.1906679).
- [BS16] A. Beveridge and J. Shan. "Network of Thrones". In: *Math Horizons* 23.4 (2016), pp. 18–22. DOI: [10.4169/mathhorizons.23.4.18](https://doi.org/10.4169/mathhorizons.23.4.18).
- [BV14] P. Boldi and S. Vigna. "Axioms for centrality". In: *Internet Mathematics* 10.3–4 (2014), pp. 222–262. DOI: [10.1080/15427951.2013.865686](https://doi.org/10.1080/15427951.2013.865686).
- [Bol+13] A. Bolioli, M. Casu, M. Lana, and R. Roda. "Exploring the Betrothed Lovers". In: *Workshop on Computational Models of Narrative*. 2013, pp. 30–35. DOI: [10.4230/OASICS.CMN.2013.30](https://doi.org/10.4230/OASICS.CMN.2013.30).

References II

- [Bon72] P. Bonacich. "Factoring and weighting approaches to status scores and clique identification". In: *Journal of Mathematical Sociology* 2.1 (1972), pp. 113–120. DOI: [10.1080/0022250X.1972.9989806](https://doi.org/10.1080/0022250X.1972.9989806).
- [Bon+16] A. Bonato, D. R. D'Angelo, E. R. Elenberg, D. F. Gleich, and Y. Hou. "Mining and modeling character networks". In: *International Workshop on Algorithms and Models for the Web-Graph*. Vol. 10088. Lecture Notes in Computer Science. 2016, pp. 100–114. DOI: [10.1007/978-3-319-49787-7_9](https://doi.org/10.1007/978-3-319-49787-7_9).
- [BT93] D. Bordwell and K. Thompson. *Film Art: An Introduction*. McGraw-Hill, 1993. URL: <https://www.mhprofessional.com/9780073535104-usa-film-art-an-introduction>.
- [BM13] G. Bossaert and N. Meidert. "'We Are Only as Strong as We Are United, as Weak as We Are Divided' a Dynamic Analysis of the Peer Support Networks in the Harry Potter Books". In: *Open Journal of Applied Sciences* 3 (2013), pp. 174–185. DOI: [10.4236/ojapps.2013.32024](https://doi.org/10.4236/ojapps.2013.32024).
- [Bos+19] X. Bost, S. Gueye, V. Labatut, M. Larson, G. Linarès, D. Malinas, and R. Roth. "Remembering Winter Was Coming: Character-oriented Video Summaries of TV Series". In: *Multimedia Tools and Applications* 78.24 (2019), pp. 35373–35399. DOI: [10.1007/s11042-019-07969-4](https://doi.org/10.1007/s11042-019-07969-4).
- [Bos+16] X. Bost, V. Labatut, S. Gueye, and G. Linarès. "Narrative smoothing: dynamic conversational network for the analysis of TV series plots". In: *Advances in Social Networks Analysis and Mining - 2nd International Workshop on Dynamics in Networks*. 2016, pp. 1111–1118. DOI: [10.1109/ASONAM.2016.7752379](https://doi.org/10.1109/ASONAM.2016.7752379).
- [CH56] D. Cartwright and F. Harary. "Structural balance: A generalization of Heider's theory". In: *Psychological Review* 63 (1956), pp. 277–293. DOI: [10.1037/h0046049](https://doi.org/10.1037/h0046049).

References III

- [CSR18] S. Chaturvedi, S. Srivastava, and D. Roth. "Where Have I Heard This Story Before? Identifying Narrative Similarity in Movie Remakes". In: *Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*. Vol. 2. 2018, pp. 673–678. URL: <https://aclanthology.coli.uni-saarland.de/papers/N18-2106/n18-2106>.
- [CK07] Y.-M. Choi and H.-J. Kim. "A directed network of greek and roman mythology". In: *Physica A* 382.2 (2007), pp. 665–671. DOI: [10.1016/j.physa.2007.04.035](https://doi.org/10.1016/j.physa.2007.04.035).
- [DY10] L. Ding and A. Yilmaz. "Learning Relations Among Movie Characters: A Social Networks Perspective". In: *European Conference on Computer Vision*. Vol. 6314. Lecture Notes in Computer Science. 2010, pp. 410–423. DOI: [10.1007/978-3-642-15561-1_30](https://doi.org/10.1007/978-3-642-15561-1_30).
- [Dor17] P. Doreian. "Reflections on Studying Signed Networks". In: *Journal of Interdisciplinary Methodologies and Issues in Science* 2 (2017), pp. 2.1–2.14. DOI: [10.18713/JIMIS-170117-2-1](https://doi.org/10.18713/JIMIS-170117-2-1).
- [Els12] M. Elsner. "Character-based Kernels for Novelistic Plot Structure". In: *13th Conference of the European Chapter of the Association for Computational Linguistics*. 2012, pp. 634–644. URL: <http://www.aclweb.org/anthology/E12-1065>.
- [EDM10] D. K. Elson, N. Dames, and K. R. McKeown. "Extracting social networks from literary fiction". In: *48th annual meeting of the association for computational linguistics*. 2010, pp. 138–147. URL: <http://dl.acm.org/citation.cfm?id=1858696>.
- [For10] S. Fortunato. "Community detection in graphs". In: *Physics Reports* 486.3–5 (2010), pp. 75–174. DOI: [10.1016/j.physrep.2009.11.002](https://doi.org/10.1016/j.physrep.2009.11.002).

References IV

- [Fre77] L. C. Freeman. "A Set of Measures of Centrality Based on Betweenness". In: *Sociometry* 40.1 (1977), pp. 35–41. DOI: [10.2307/3033543](https://doi.org/10.2307/3033543).
- [Fre78] L. C. Freeman. "Centrality in Social Networks I: Conceptual Clarification". In: *Social Networks* 1.3 (1978), pp. 215–239. DOI: [10.1016/0378-8733\(78\)90021-7](https://doi.org/10.1016/0378-8733(78)90021-7).
- [Gle07] P. M. Gleiser. "How to become a superhero". In: *Journal of Statistical Mechanics* 2007.09 (2007), P09020. DOI: [10.1088/1742-5468/2007/09/P09020](https://doi.org/10.1088/1742-5468/2007/09/P09020).
- [Har69] F. Harary. *Graph Theory*. Addison-Wesley, 1969. URL: <http://www.dtic.mil/dtic/tr/fulltext/u2/705364.pdf>.
- [Het+15] L. Hettinger, M. Becker, I. Reger, F. Jannidis, and A. Hotho. "Genre Classification on German Novels". In: *26th International Workshop on Database and Expert Systems Applications*. 2015. DOI: [10.1109/DEXA.2015.62](https://doi.org/10.1109/DEXA.2015.62).
- [Hol+19] A. J. Holanda, M. Matias, S. M. S. P. Ferreira, G. M. L. Benevides, and O. Kinouchi. "Character Networks and Book Genre Classification". In: *International Journal of Modern Physics C* 30.08 (2019), p. 1950058. DOI: [10.1142/S012918311950058X](https://doi.org/10.1142/S012918311950058X).
- [Jay+15] P. A. Jayannavar, A. Agarwal, M. Ju, and O. Rambo. "Validating literary theories using automatic social network extraction". In: *4th Workshop on Computational Linguistics for Literature*. 2015, pp. 32–41. URL: <http://anthology.aclweb.org/W/W15/W15-07.pdf#page=46>.
- [Jun+04] B. Jung, T. Kwak, J. Song, and Y. Lee. "Narrative abstraction model for story-oriented video". In: *12th annual ACM international conference on Multimedia*. 2004, pp. 828–835. DOI: [10.1145/1027527.1027720](https://doi.org/10.1145/1027527.1027720).
- [JYP13] J. J. Jung, E. You, and S.-B. Park. "Emotion-based character clustering for managing story-based contents: a cinemetric analysis". In: *Multimedia Tools and Applications* 65.1 (2013), pp. 29–45. DOI: [10.1007/s11042-012-1133-x](https://doi.org/10.1007/s11042-012-1133-x).

References V

- [Kos+05] D. Koschützki, K. A. Lehmann, L. Peeters, S. Richter, D. Tenfelde-Podehl, and O. Zlotowski. "Centrality Indices". In: *Network Analysis – Methodological Foundations*. Vol. 3418. Lecture Notes in Computer Science. Springer, 2005, pp. 16–61. DOI: [10.1007/978-3-540-31955-9_3](https://doi.org/10.1007/978-3-540-31955-9_3).
- [KS17] H.-C. Kwon and K.-H. Shim. "An Improved Method of Character Network Analysis for Literary Criticism: A Case Study of Hamlet". In: *International Journal of Contents* 13.3 (2017), pp. 43–48. DOI: [10.5392/IJoC.2017.13.3.043](https://doi.org/10.5392/IJoC.2017.13.3.043).
- [KA15] D. Kydros and A. Anastasiadis. "Social network analysis in literature. The case of The Great Eastern by A. Embirikos". In: *5th European Congress of Modern Greek Studies of the European Society of Modern Greek Studies*. 2015, pp. 681–702. URL: https://www.researchgate.net/profile/Dimitrios_Kydros/publication/273357563_Social_network_analysis_in_literature._The_case_of_The_Great_Eastern_by_A._Embirikos/links/54ff172f0cf2672e22419bd6.pdf.
- [KNE15] D. Kydros, P. Notopoulos, and G. Exarchos. "Homer's Iliad – a social network analytic approach". In: *International Journal of Humanities and Arts Computing* 9 (2015), pp. 115–132. DOI: [10.3366/ijhac.2015.0141](https://doi.org/10.3366/ijhac.2015.0141).
- [LB19] V. Labatut and X. Bost. "Extraction and Analysis of Fictional Character Networks: A Survey". In: *ACM Computing Surveys* 52.5 (2019), p. 89. DOI: [10.1145/3344548](https://doi.org/10.1145/3344548). {hal-02173918}.
- [LJ19] O.-J. Lee and J. J. Jung. "Modeling affective character network for story analytics". In: *Future Generation Computer Systems* 92 (2019), pp. 458–478. DOI: [10.1016/j.future.2018.01.030](https://doi.org/10.1016/j.future.2018.01.030).
- [LYL19] J. Li, D. Yang, and P. Lv. "Visualize classic play's composing patterns: a weighted motif mining framework". In: *Multimedia Tools and Applications* 78.5 (2019), pp. 5989–6012. DOI: [10.1007/s11042-018-6405-7](https://doi.org/10.1007/s11042-018-6405-7).

References VI

- [Lia+09] C. Liang, Y/ Zhang, J. Cheng, C.-S. Xu, and H-Q. Lu. "A novel role-based movie scene segmentation method". In: *Pacific-Rim Conference on Multimedia*. Vol. 5879. Lecture Notes in Computer Science. 2009, pp. 917–922. DOI: [10.1007/978-3-642-10467-1_82](https://doi.org/10.1007/978-3-642-10467-1_82).
- [LA17] D. Liu and L. Albergante. "Balance of thrones: a network study on 'Game of Thrones'". In: *arXiv cs.SI* (2017), p. 1707.05213. URL: <https://arxiv.org/abs/1707.05213>.
- [MK12] P. Mac Carron and R. Kenna. "Universal Properties of Mythological Networks". In: *Europhysics Letters* 99.2 (2012), p. 28002. DOI: [10.1209/0295-5075/99/28002](https://doi.org/10.1209/0295-5075/99/28002).
- [Mac14] P. MacCarron. "A Network Theoretic Approach to Comparative Mythology". PhD Thesis. Applied Mathematics Research Centre, Coventry University, 2014. URL: <https://curve.coventry.ac.uk/open/file/9bfc043d-497e-4217-82ab-e19963b53290/1/maccarroncomb.pdf>.
- [MP16] S. Min and J. Park. "Network Science and Narratives: Basic Model and Application to Victor Hugo's *Les Misérables*". In: *7th Workshop on Complex Networks CompleNet*. Vol. 644. Studies in Computational Intelligence. 2016, pp. 257–265. DOI: [10.1007/978-3-319-30569-1_19](https://doi.org/10.1007/978-3-319-30569-1_19).
- [Mor11] F. Moretti. "Network Theory, Plot Analysis". In: *Stanford Literary Lab 2* (2011). URL: <http://litlab.stanford.edu/LiteraryLabPamphlet2.pdf>.
- [MCC18] S. Muhuri, S. Chakraborty, and S. N. Chakraborty. "Extracting Social Network and Character Categorization From Bengali Literature". In: *IEEE Transactions on Computational Social Systems* 5.2 (2018), pp. 371–381. DOI: [10.1109/TCSS.2018.2798699](https://doi.org/10.1109/TCSS.2018.2798699).

References VII

- [NB13] E. T. Nalisnick and H. S. Baird. "Character-to-Character Sentiment Analysis in Shakespeare's Plays". In: *51st Annual Meeting of the Association for Computational Linguistics*. 2013. URL: <http://www.aclweb.org/anthology/P13-2085>.
- [New03a] M. E. J. Newman. "Mixing patterns in networks". In: *Physical Review E* 67 (2003), p. 026126. DOI: [10.1103/PhysRevE.67.026126](https://doi.org/10.1103/PhysRevE.67.026126).
- [New03b] M. E. J. Newman. "The structure and function of complex networks". In: *SIAM Review* 45 (2003), pp. 167–256. DOI: [10.1137/S003614450342480](https://doi.org/10.1137/S003614450342480).
- [POJ12] S.-B. Park, K.-J. Oh, and G.-S. Jo. "Social network analysis in a movie using Character-Net". In: *Multimedia Tools and Applications* 59.2 (Jan. 2012), pp. 601–627. DOI: [10.1007/s11042-011-0725-1](https://doi.org/10.1007/s11042-011-0725-1).
- [Pop+15] F. Pope, R. A. Shirvani, Mugizi R. Rwebangira, M. Chouikha, A. Taylor, A. Alarcon Ramirez, and A. Torfi. "Automatic Detection of Small Groups of Persons, Influential Members, Relations and Hierarchy in Written Conversations Using Fuzzy Logic". In: *International Conference on Data Mining*. 2015, pp. 155–161. URL: <https://arxiv.org/abs/1610.01720v1>.
- [Pra+16] S. D. Prado, S. R. Dahmen, A. L. C. Bazzan, P. Mac Carron, and R. Kenna. "Temporal Network Analysis of Literary Texts". In: *Advances in Complex Systems* 19.3 (2016), p. 1650005. DOI: [10.1142/S0219525916500053](https://doi.org/10.1142/S0219525916500053).
- [Roc14] Y. Rochat. "Character Networks and Centrality". PhD thesis. Université de Lausanne, 2014. URL: http://infoscience.epfl.ch/record/203889/files/yrochat_thesis_infoscience.pdf.
- [RT17] Y. Rochat and M. Triclot. "Les réseaux de personnages de science-fiction : échantillons de lectures intermédiaires". French. In: *ReS Futuræ* 10 (2017). DOI: [10.4000/resf.1183](https://doi.org/10.4000/resf.1183).

References VIII

- [Sac12] G. A. Sack. "Character Networks for Narrative Generation". In: *8th Artificial Intelligence and Interactive Digital Entertainment Conference - Intelligent Narrative Technologies Workshop*. 2012, pp. 38–43. URL: <http://www.aaai.org/ocs/index.php/AIIDE/AIIDE12/paper/view/5550>.
- [Sac14] G. A. Sack. "Character Networks for Narrative Generation: Structural Balance Theory and the Emergence of Proto-Narratives". In: *Complexity and the Human Experience - Modeling Complexity in the Humanities and Social Sciences*. Pan Stanford Publishing - CRC Press, 2014. Chap. 4, pp. 81–104. DOI: [10.4032/9789814463270](https://doi.org/10.4032/9789814463270).
- [Sac13] G. A. Sack. "Character networks for narrative generation: Structural balance theory and the emergence of proto-narratives". In: *Workshop on Computational Models of Narrative*. 2013. DOI: [10.4230/OASICS.CMN.2013.183](https://doi.org/10.4230/OASICS.CMN.2013.183). URL: <http://drops.dagstuhl.de/opus/volltexte/2013/4161/pdf/p183-sack.pdf>.
- [Seo+13] J. Seo, G.-M. Park, S.-H. Kim, and H.-G. Cho. "Characteristic Analysis of Social Network Constructed from Literary Fiction". In: *International Conference on Cyberworlds*. 2013, pp. 147–150. DOI: [10.1109/CW.2013.72](https://doi.org/10.1109/CW.2013.72).
- [SH05] J. Stiller and M. Hudson. "Weak Links and Scene Cliques Within the Small World of Shakespeare". In: *Journal of Cultural and Evolutionary Psychology* 3.1 (2005), pp. 57–73. DOI: [10.1556/JCEP.3.2005.1.4](https://doi.org/10.1556/JCEP.3.2005.1.4).
- [SND03] J. Stiller, D. Nettle, and R. I. M. Dunbar. "The small world of Shakespeare's plays". In: *Human Nature* 14.4 (2003), pp. 397–408. DOI: [10.1007/s12110-003-1013-1](https://doi.org/10.1007/s12110-003-1013-1).
- [SC13] S. Sudhahar and N. Cristianini. "Automated Analysis of Narrative Content for Digital Humanities". In: *International Journal of Advanced Computer Science* 3.9 (2013), pp. 440–447. DOI: [10.1.1.429.3639](https://doi.org/10.1.1.429.3639).

References IX

- [SKG13] C. Suen, L. Kuenzel, and S. Gil. "Extraction and analysis of character interaction networks from plays and movies". In: *Digital Humanities*. 2013. URL: http://snap.stanford.edu/class/cs224w-2011/proj/laneyk_Finalwriteup_v1.pdf.
- [VG08] A. V. Voloshinov and I. V. Gozhanskaya. "Russian vs. English Drama in the Context of Network Theory". In: *XXth International Association of Empirical Aesthetics Biennial Congress*. 2008, pp. 19–22. URL: http://ets.ifmo.ru/tomasov/konferenc/AutoPlay/Docs/Volume%204/8_06.pdf.
- [WS98] D. J. Watts and S. H. Strogatz. "Collective dynamics of 'small-world' networks". In: *Nature* 393.6684 (1998), pp. 440–442. DOI: [10.1038/30918](https://doi.org/10.1038/30918).
- [WCW07] C.-Y. Weng, W.-T. Chu, and J.-L. Wu. "Movie analysis based on roles' social network". In: *IEEE International Conference on Multimedia and Expo*. 2007, pp. 1403–1406. DOI: [10.1109/ICME.2007.4284922](https://doi.org/10.1109/ICME.2007.4284922).
- [WCW09] C.-Y. Weng, W.-T. Chu, and J.-L. Wu. "RoleNet: Movie Analysis from the Perspective of Social Networks". In: *IEEE Transactions on Multimedia* 11.2 (2009), pp. 256–271. DOI: [10.1109/TMM.2008.2009684](https://doi.org/10.1109/TMM.2008.2009684).
- [Wol03] A. Woloch. *The One vs. the Many: Minor Characters and the Space of the Protagonist in the Novel*. Princeton University Press, 2003. URL: <http://press.princeton.edu/titles/7622.html>.
- [YW14] M.-C. Yeh and W.-P. Wu. "Clustering Faces in Movies Using an Automatically Constructed Social Network". In: *IEEE MultiMedia* 21.2 (2014), pp. 22–31. DOI: [10.1109/MMUL.2014.24](https://doi.org/10.1109/MMUL.2014.24).
- [YYL96] M. Yeung, B.-L. Yeo, and B. Liu. "Extracting story units from long programs for video browsing and navigation". In: *3rd IEEE International Conference Multimedia Computing & Systems*. 1996, pp. 296–305. DOI: [10.1109/MMCS.1996.534991](https://doi.org/10.1109/MMCS.1996.534991).

References X

- [Yos+18] J. Yose, R. Kenna, M. MacCarron, and P. MacCarron. "Network Analysis of the Viking Age in Ireland as portrayed in *Cogadh Gaedhel re Gallaibh*". In: *Royal Society Open Science* 5.1 (2018), p. 171024. DOI: [10.1098/rsos.171024](https://doi.org/10.1098/rsos.171024).