

# Extraction and Analysis of Fictional Character Networks

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*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

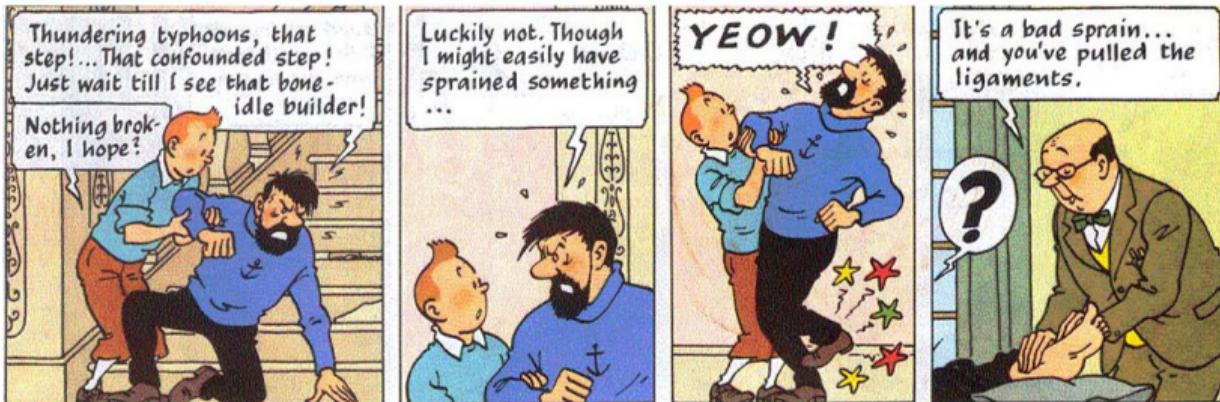


Tintin #21, *The Castafiore Emerald*, by Hergé, 1963, published by Casterman (FR) / Methuen (EN).

# 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

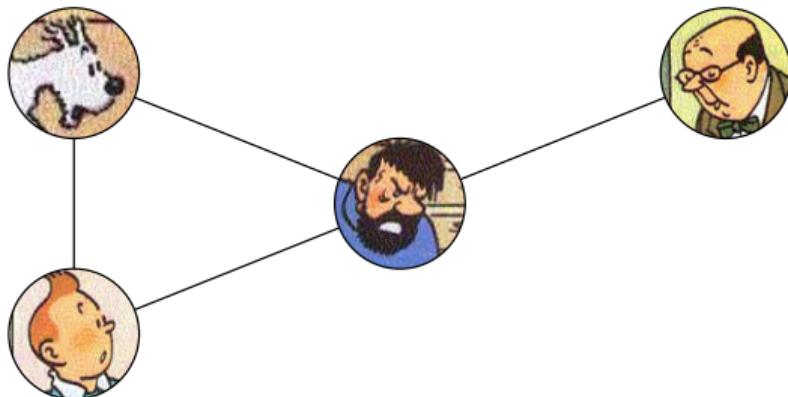
## Plot Modeling

- 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

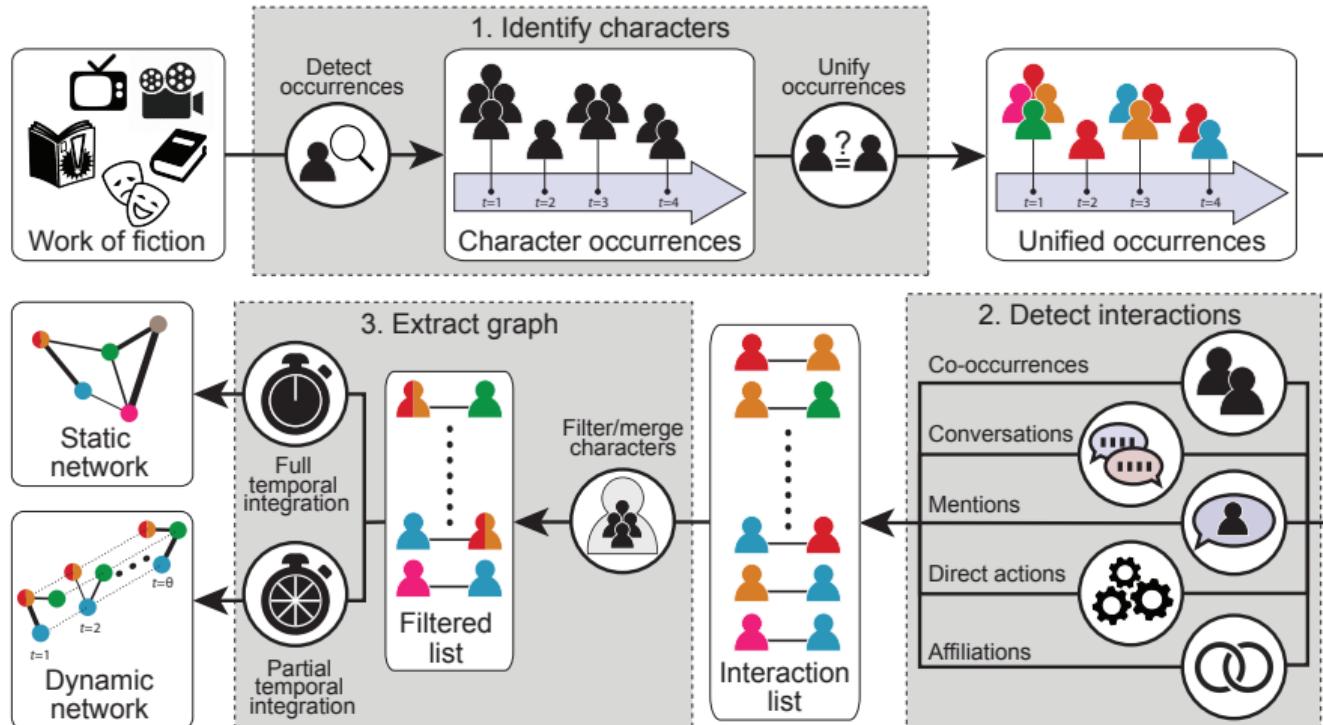


Section 2

## Network Extraction

# Network Extraction

## Overview of the Extraction Process



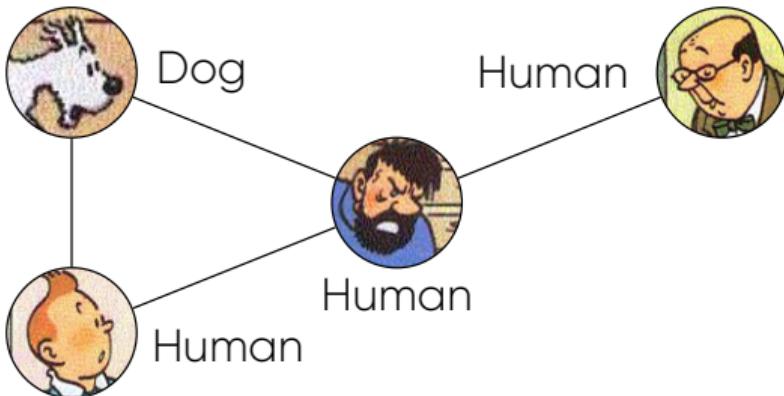
# Network Extraction

## 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)
  - **Multilayer graph**



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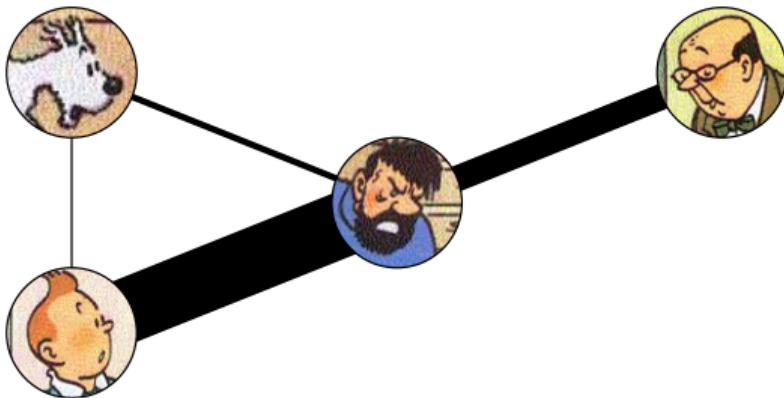
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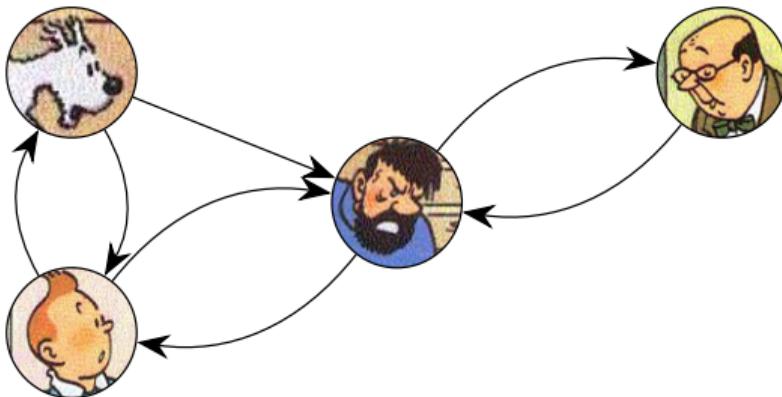
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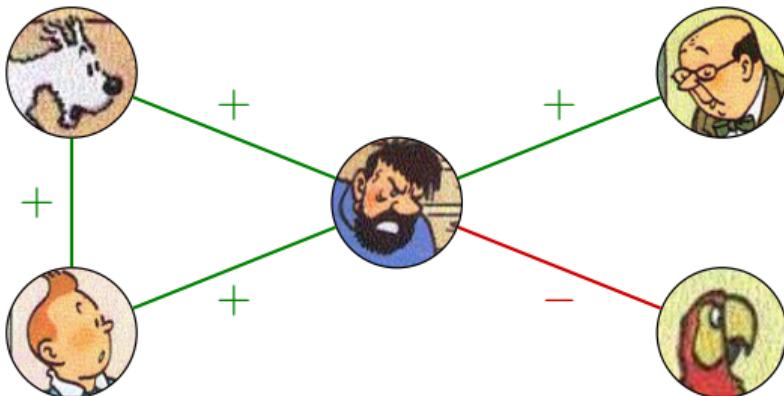
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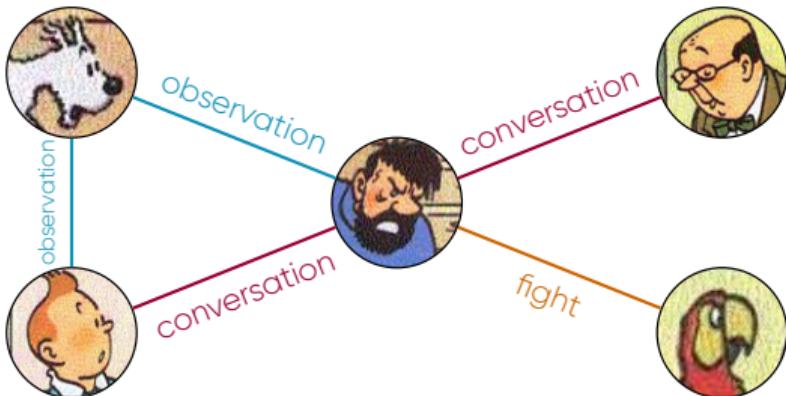
→ Signed graph
- Interaction semantic **category**
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Multilabel graph



# Network Extraction Graph Construction

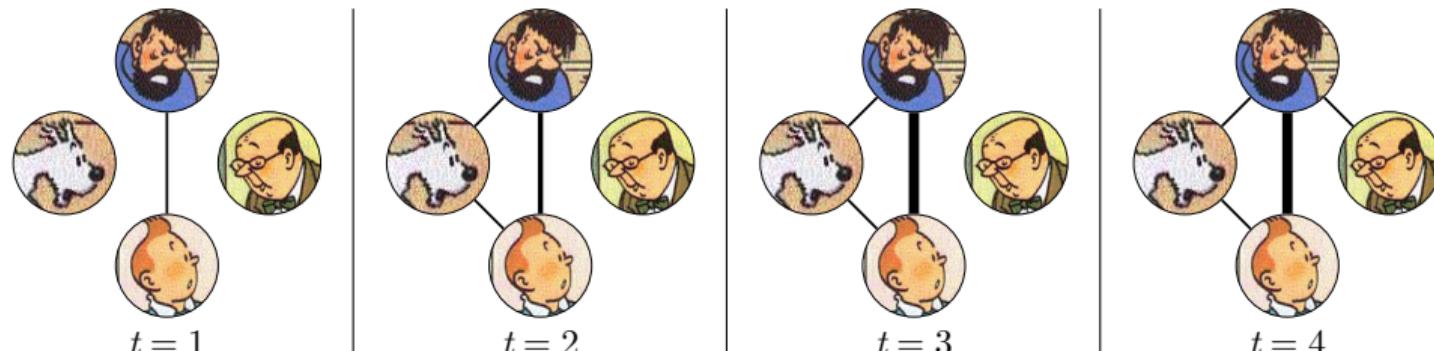
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→ **Directed graph**
- Interaction **polarity**
  - friendly vs. hostile  
→ **Signed graph**
- Interaction semantic **category**
  - Ex. *murder* vs. *other* (GoT)  
→ **Multiplex graph**



# 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

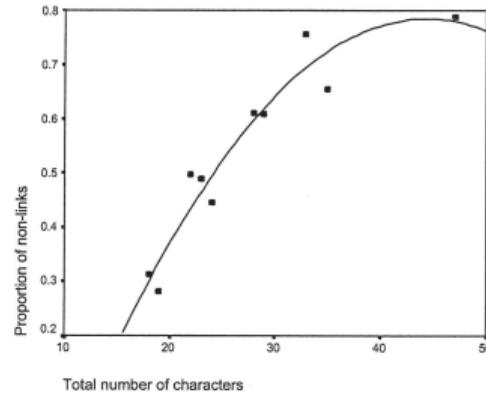
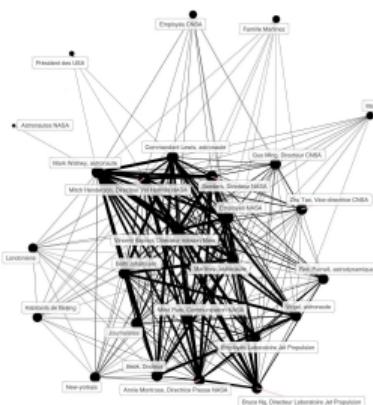
## Overview

- 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

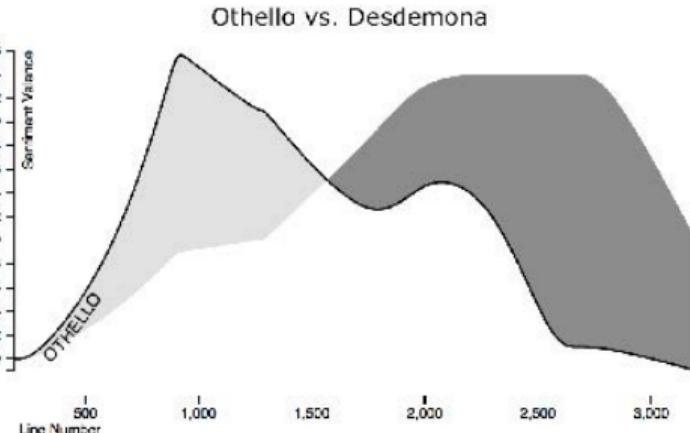
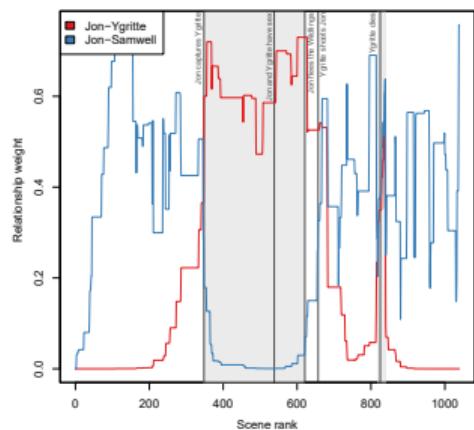
- **Density**: proportion of existing edges
    - Directly tied to certain aspects of the narrative
    - Dense & centerless → *behind closed doors* story type [RT17]
    - Density w.r.t. number of characters
      - Decrease → writer limits characters in subplots [SND03; SH05]
    - Sparse & moderate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



# Descriptive Analysis

## Edge Weights

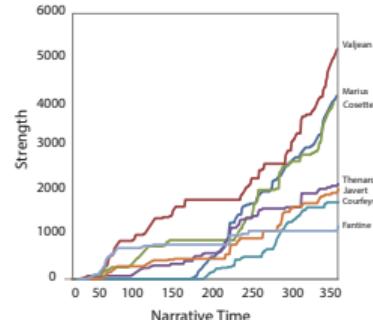
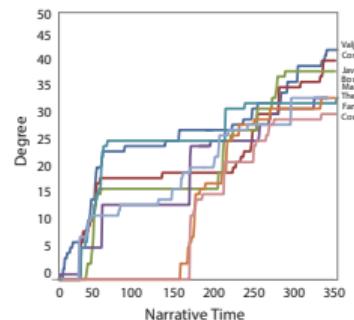
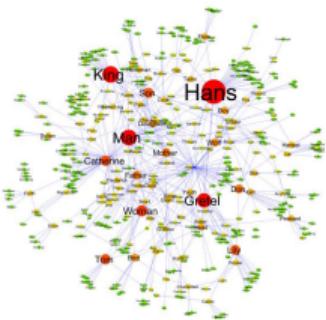
- Weights: intensity of the relation
  - Used comparatively: w.r.t. other characters; or w.r.t. time
  - Weak vs. strong edges → Major–minor vs. Major–Major [Sac12]
  - Power law distribution
    - Reveals the artificiality of the collaborations [Gle07]
    - Focus on top-2 edges to assess level of plot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



# Descriptive Analysis

## Degree & Strength I

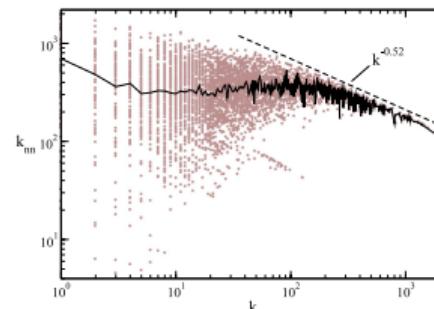
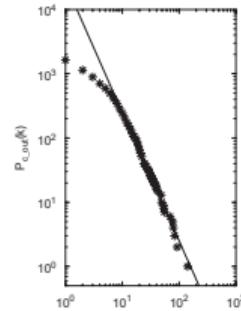
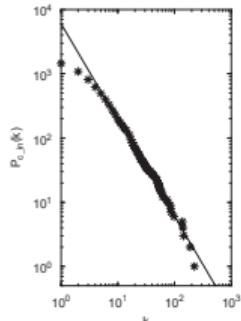
- **Degree**: number of (un)directed edges attached to a vertex
- **Strength**: weighted generalization (sum of edge weights)
  - Hubs → protagonists [SC13], antagonists [MCC18], but also narrators [Roc14], authority figures [SC13]
- **Directed edges**: incoming vs. outgoing degree/strength
  - Ex. Incoming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



# Descriptive Analysis

## Degree & Strength II

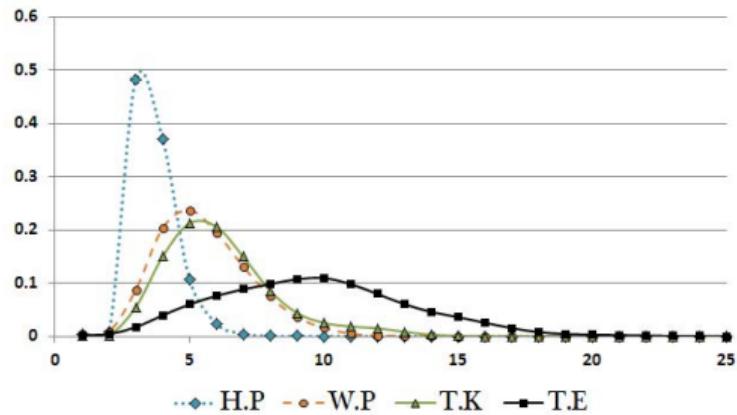
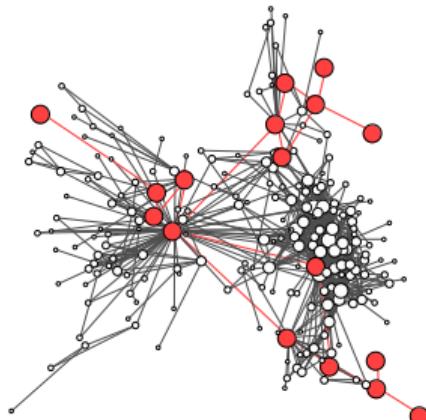
- Distribution:
  - (truncated) power law when dominated by one or a few chars
    - Scale-free networks are frequent in other domains
  - But other distributions observed (due to filtering?)
- Assortativity: degree correlation between attached vertices
  - Character networks generally disassortative [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

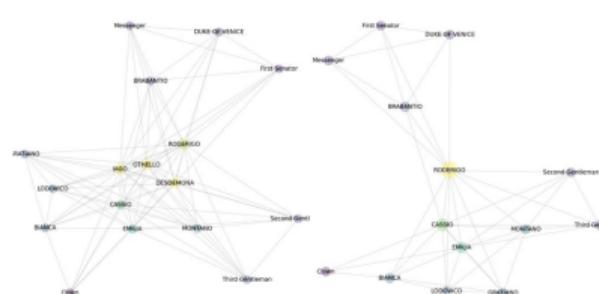
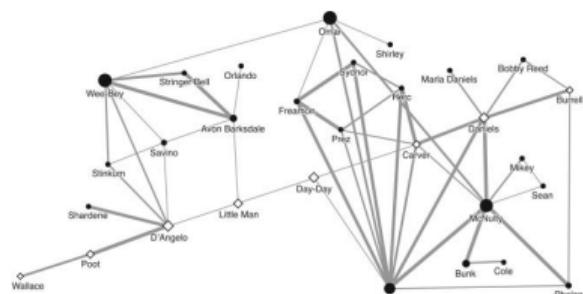
- Geodesic distance: length of the shortest path (on the graph)
- Small-world: requires relatively small average distance or logarithmic growth (+transitivity) [WS98]
- Diameter & average distance: compactness of the story
- Small value: narrative proximity between characters [Roc14]
- Large diameter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

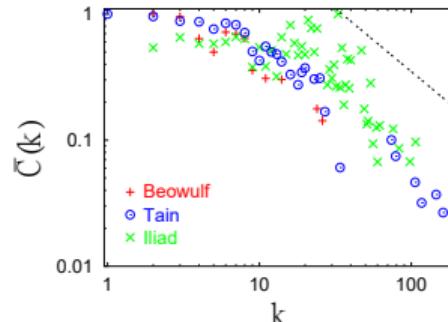
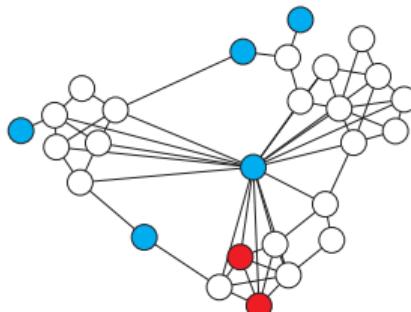
- **Closeness**: the reciprocal of the average (or total) distance between the considered vertex and the rest of the network [Bav50]
  - Measures how close a character is from all the others, in terms of character-space
  - Used to identify the network center [AMR02]
  - Identify important minor characters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



# Descriptive Analysis

## Transitivity

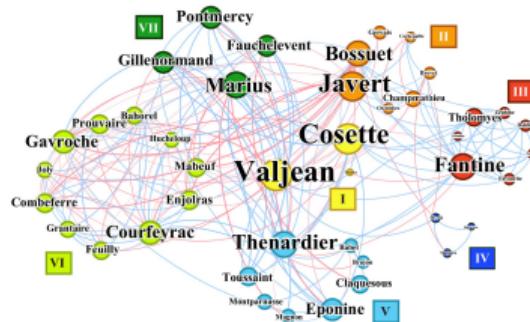
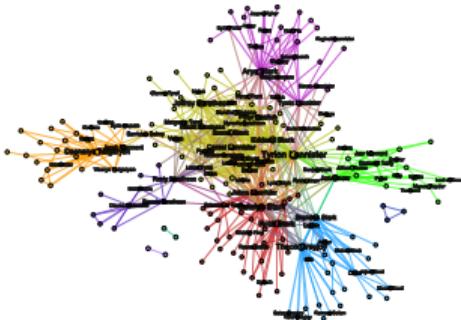
- **Transitivity** (a.k.a. Clustering Coefficient): ratio of closed triads to open triads, counted locally or globally
  - Small-world property requires high transitivity [WS98]
  - High in many character networks [AMR02; SND03; MK12; AS14]
  - High global → presence of cliquish groups of characters appearing recurrently together [SND03]
  - Low local → 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] → **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 ≈ 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

# Applications Overview

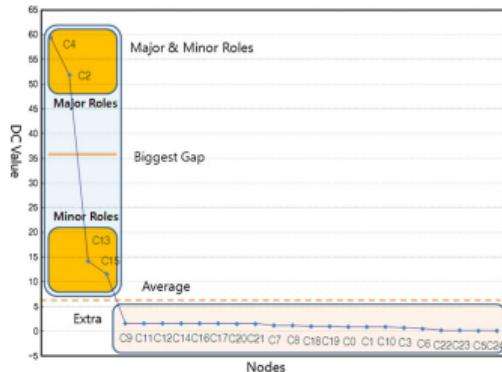
Main applications of character networks:

- 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

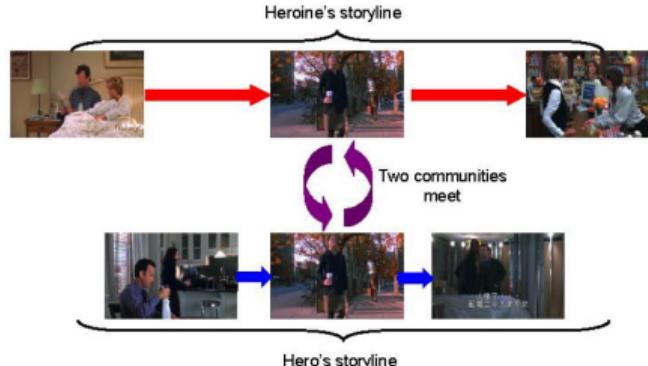
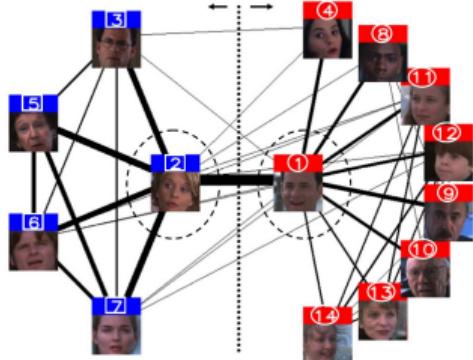
## Classification of Fiction Works

- **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

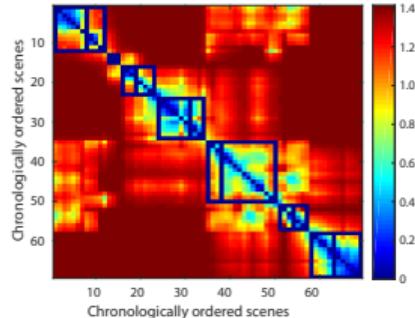
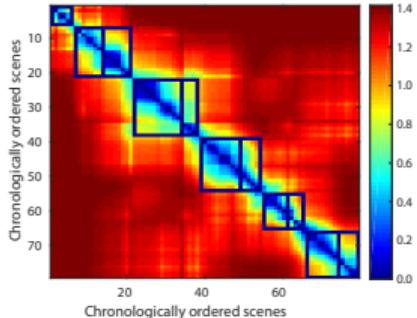
- **Storyline detection:** identify multiple intertwined subplots
  - Assumption: each storyline organized around a leading character [WCW07]
  - Methods:
    - ① Identify important characters and their entourage (communities)
    - ② Match scenes and communities
    - ③ Multiple matching → point of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

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- Online list of character network-related papers<sup>2</sup> (and other resources), regularly updated

<sup>1</sup>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](https://hal-02173918)) .

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



# Questions?

Section 6

## Appendix

# Network Extraction

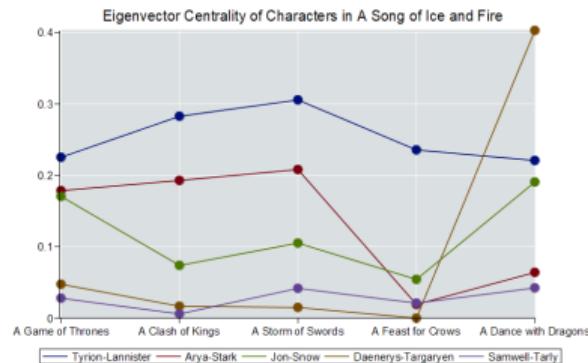
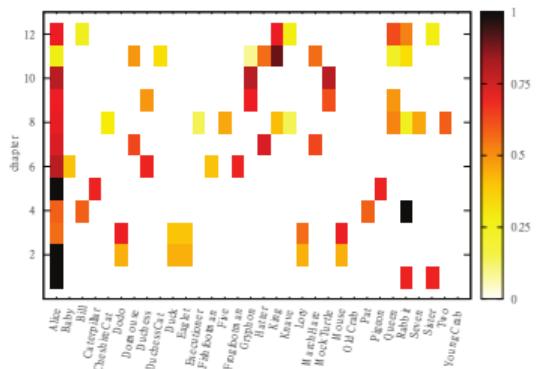
## Fiction vs. Non-Fiction

- 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
  - **Uncontroled** 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

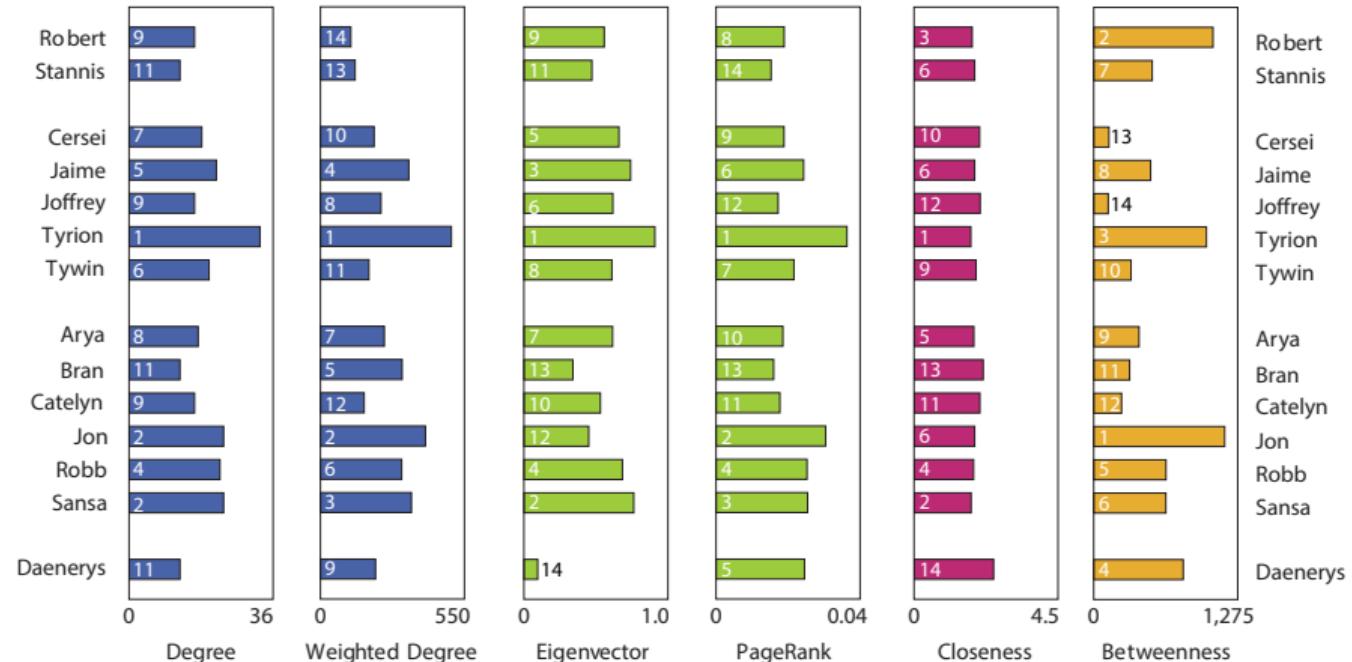
## Spectral Centrality

- 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

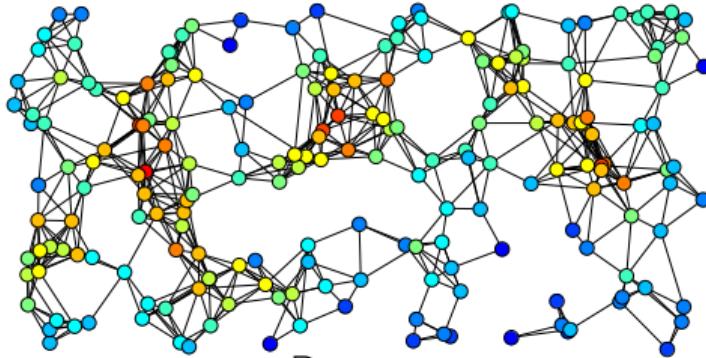
The ten most prominent actors regarding centrality

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

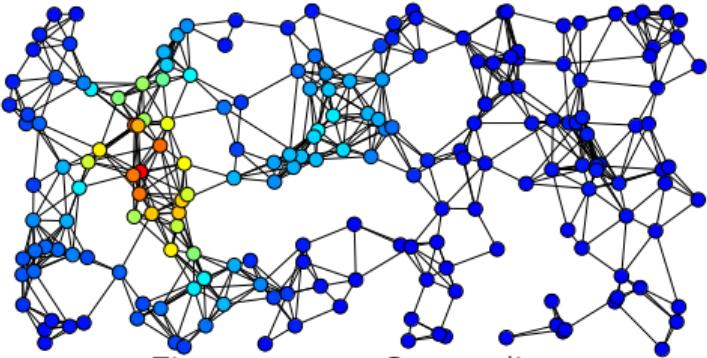
Centrality in the network of *The Iliad* [KNE15]

# Descriptive Analysis

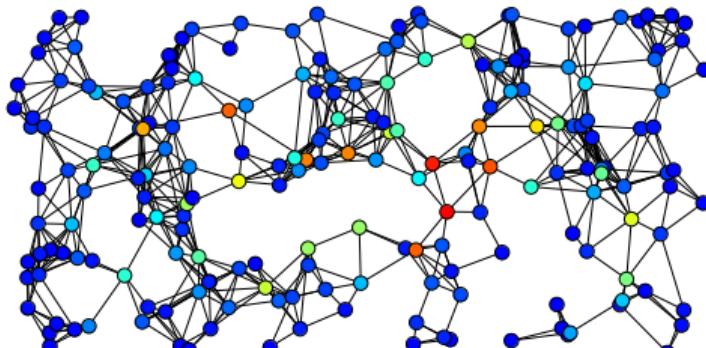
## Comparison of Centrality Measures III



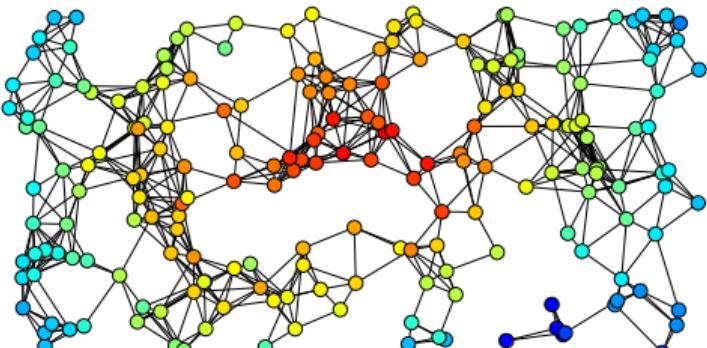
Degree



Eigenvector Centrality



Betweenness Centrality

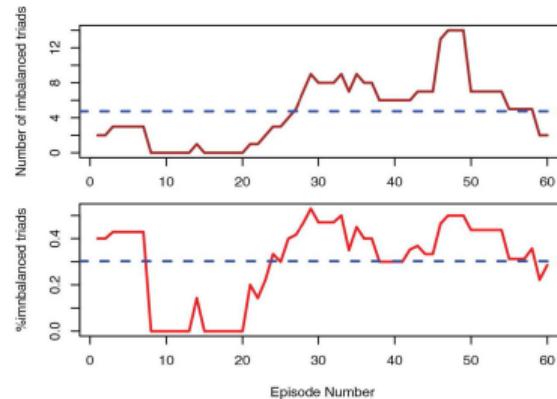
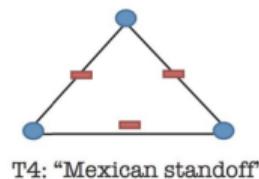
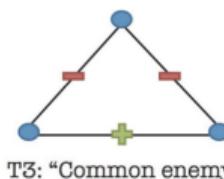
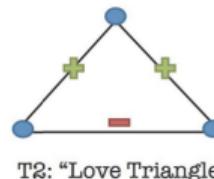
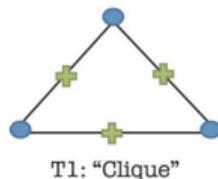


Closeness Centrality

# Descriptive Analysis

## Structural Balance

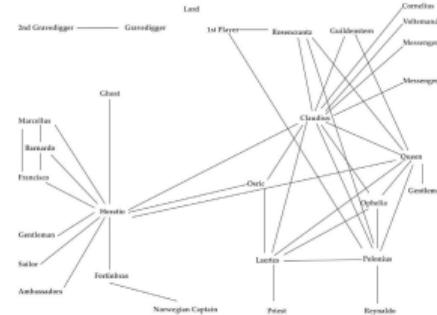
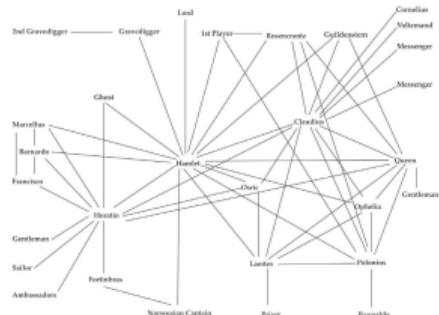
- Structurally balanced triangle: contains exactly 0 or 2 negative edges [CH56]
- Network (im)balance: proportion of (im)balanced triangles in the graph
  - Matches real-world social network balance [Yos+18]...
  - ...or not: GoT much more imbalanced [LA17]
- Evolution: brutal changes reflect narrative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



# Descriptive Analysis

## Articulation Points & Vitality

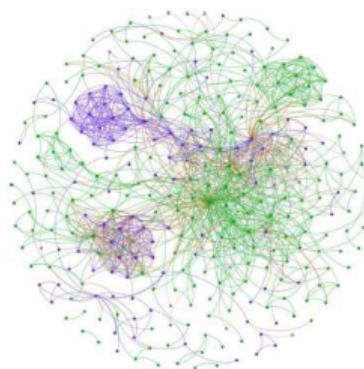
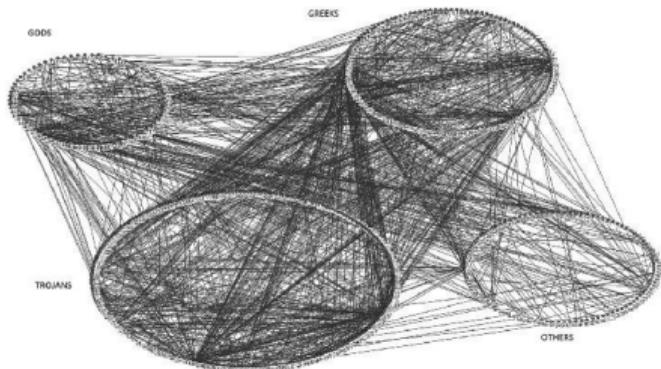
- Importance of a vertex can be assessed depending on how its **removal** affects the network
  - Assumption: important characters bring some form of **stability**
- Articulation point:** vertex whose removal disconnects the graph
  - Focus on central characters, e.g. in *Hamlet* [Mor11]
  - If disconnection: 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 *Iliad* [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
- $h_2$ : 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

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