

# Game of Thrones: A Networks Analysis

**Team Name:** Team 18  
**Team Members:** Kristina Lynch, Broghan O'Connor, Parker Rollins, Jay Sampat

**MSBR 70340**

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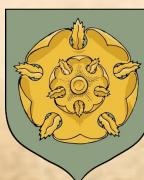
1. Defining the Network
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# What is the Network?

- What is the network?
  - Based off the 5 novels (Source: Kaggle)
  - Game of Thrones Characters from House:
    - Targaryen
    - Stark
    - Greyjoy
    - Tully
    - Lannister
    - Baratheon
    - Arryn
    - Tyrell

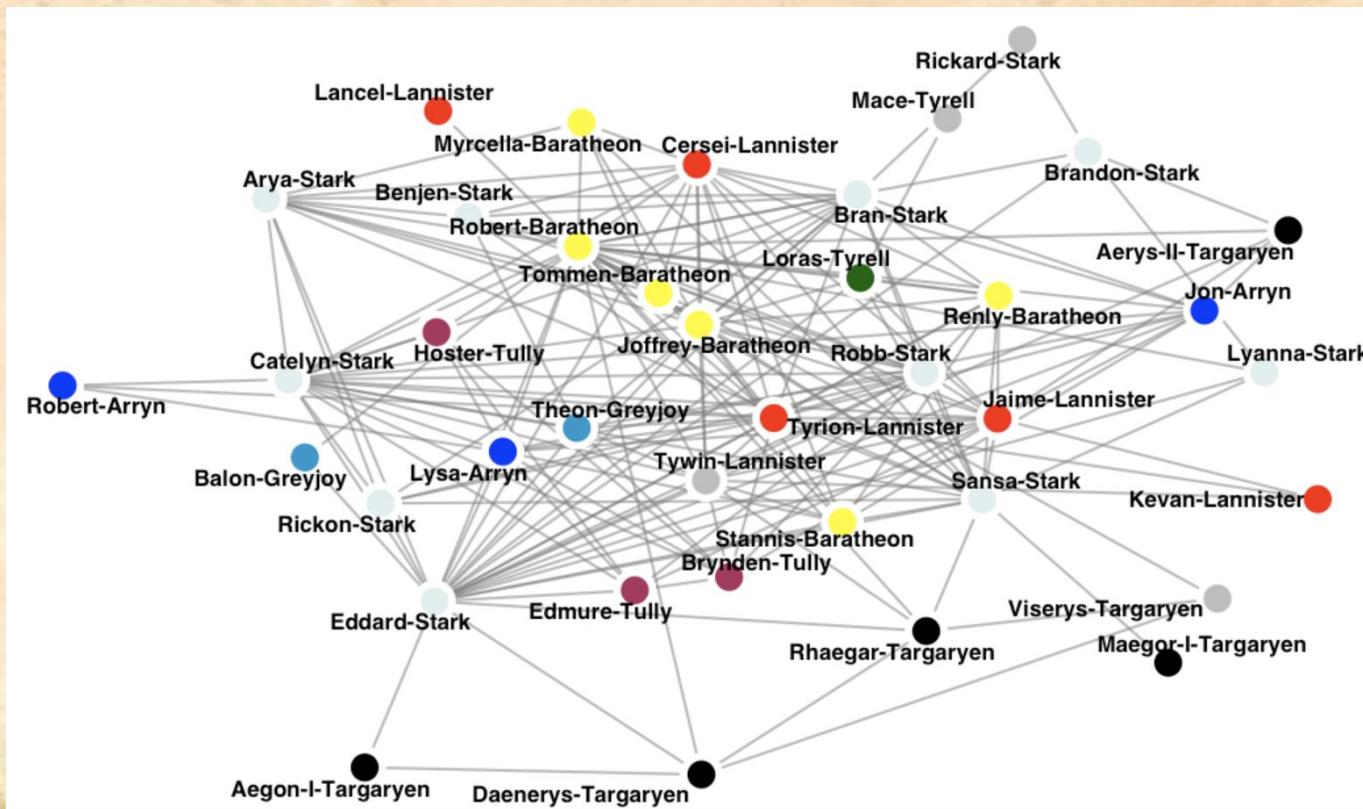
- Why is it interesting?
  - Popular television show
  - 44 million viewers per episode in final season
- Nodes
  - Characters from the GOT novels
- Ties
  - Relationships/interactions between characters (undirected)



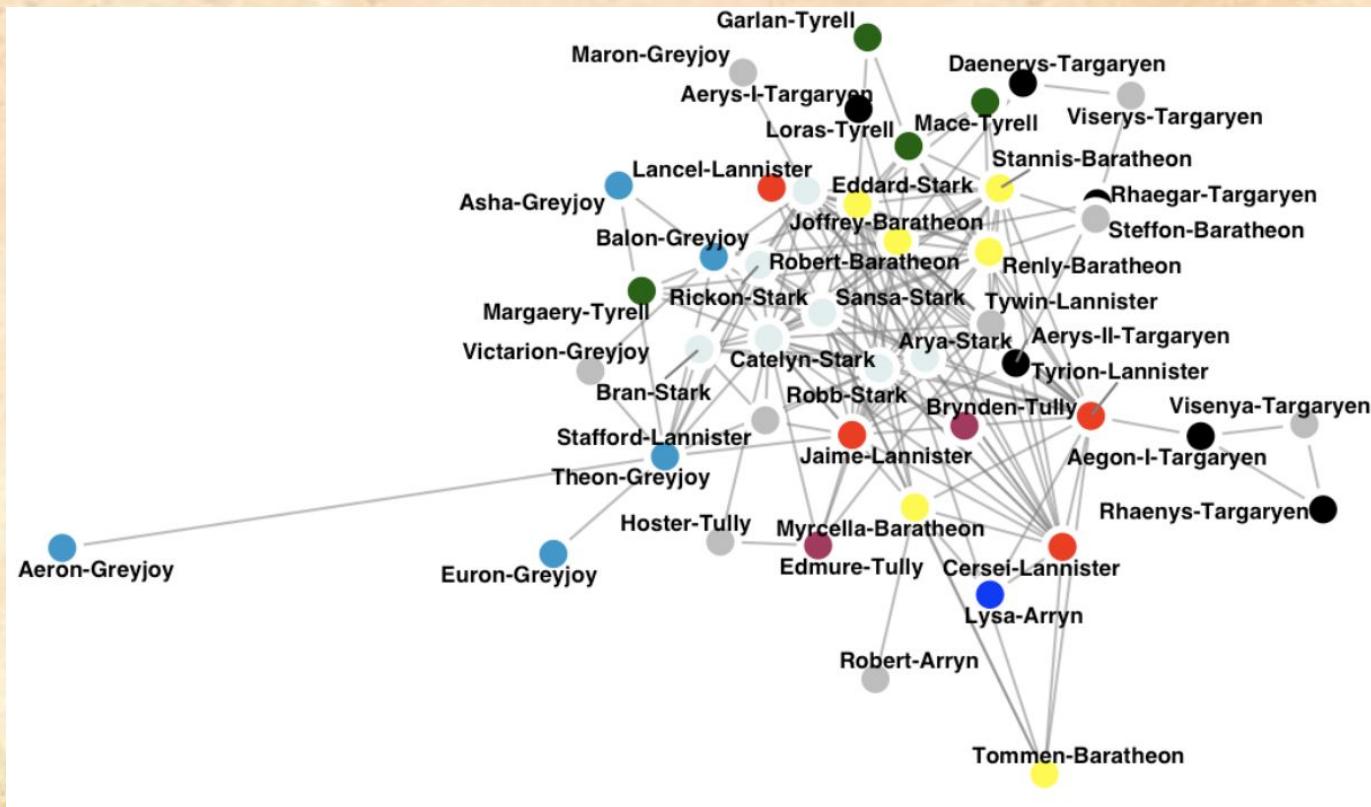
# Research Questions

- Who are the most influential characters in the GOT novels?
- How does character influence change throughout the books?
- Where do true loyalties lie (families vs. houses)?
- Does our analysis align with what happens in the books?
- How connected is the ruler of the iron throne?
- What is the outcome of interest?
  - Show evolution of character relationships across 5 books
  - Align the story told from our analysis with what happens in the books

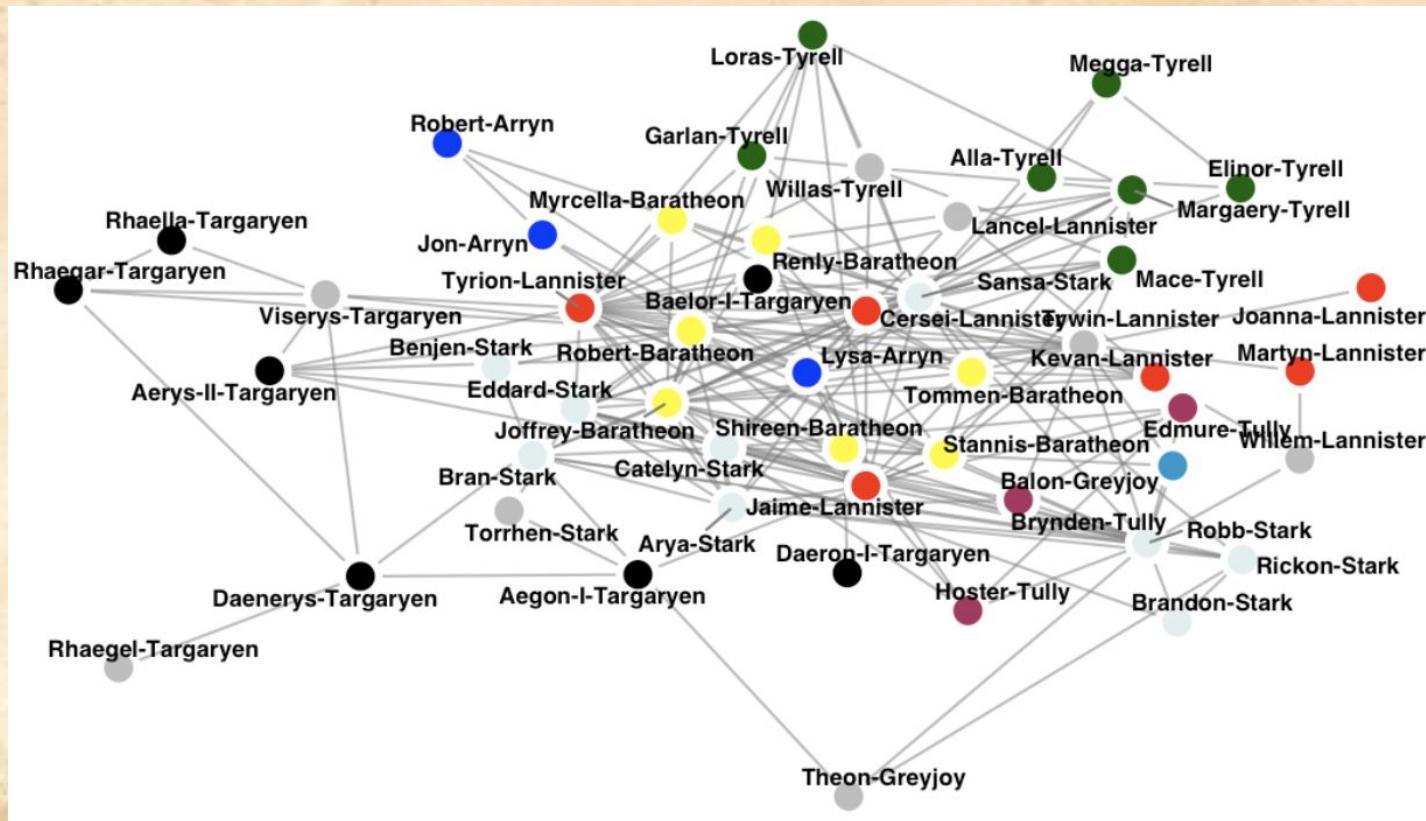
# Book 1



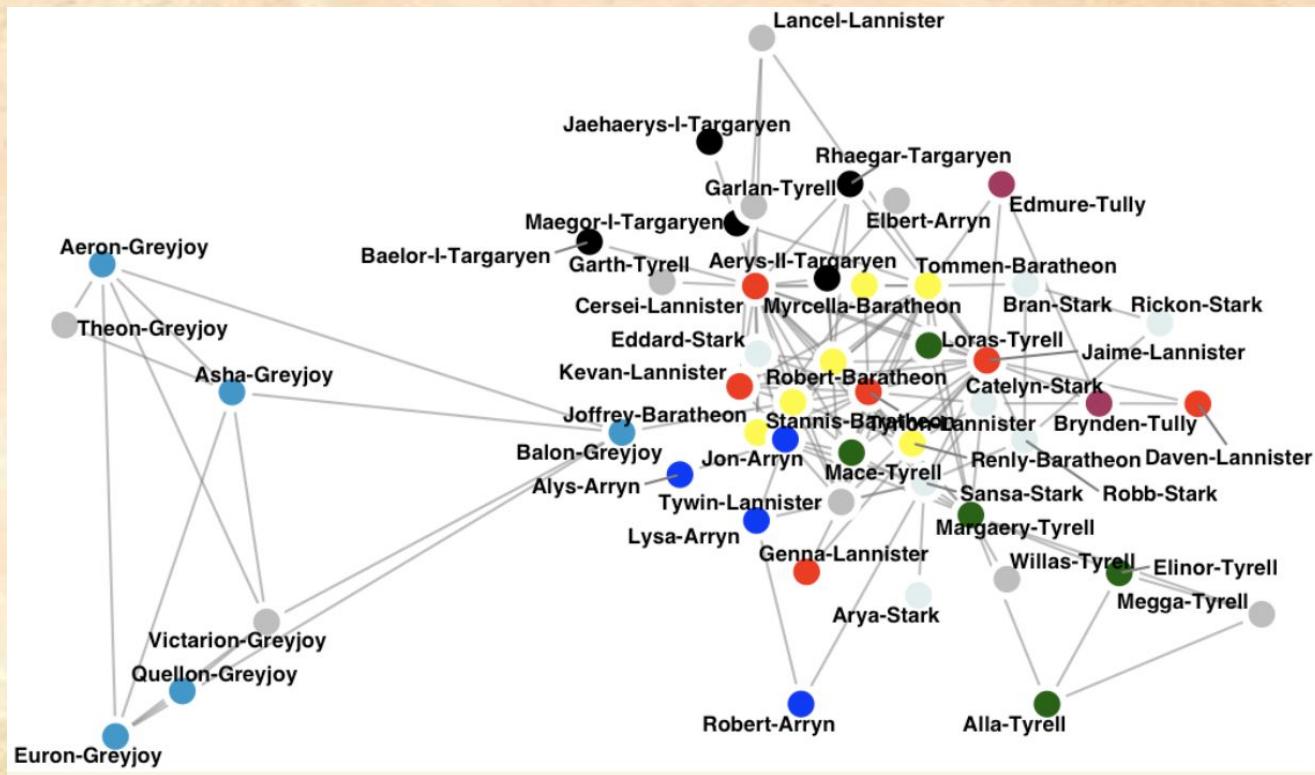
# Book 2



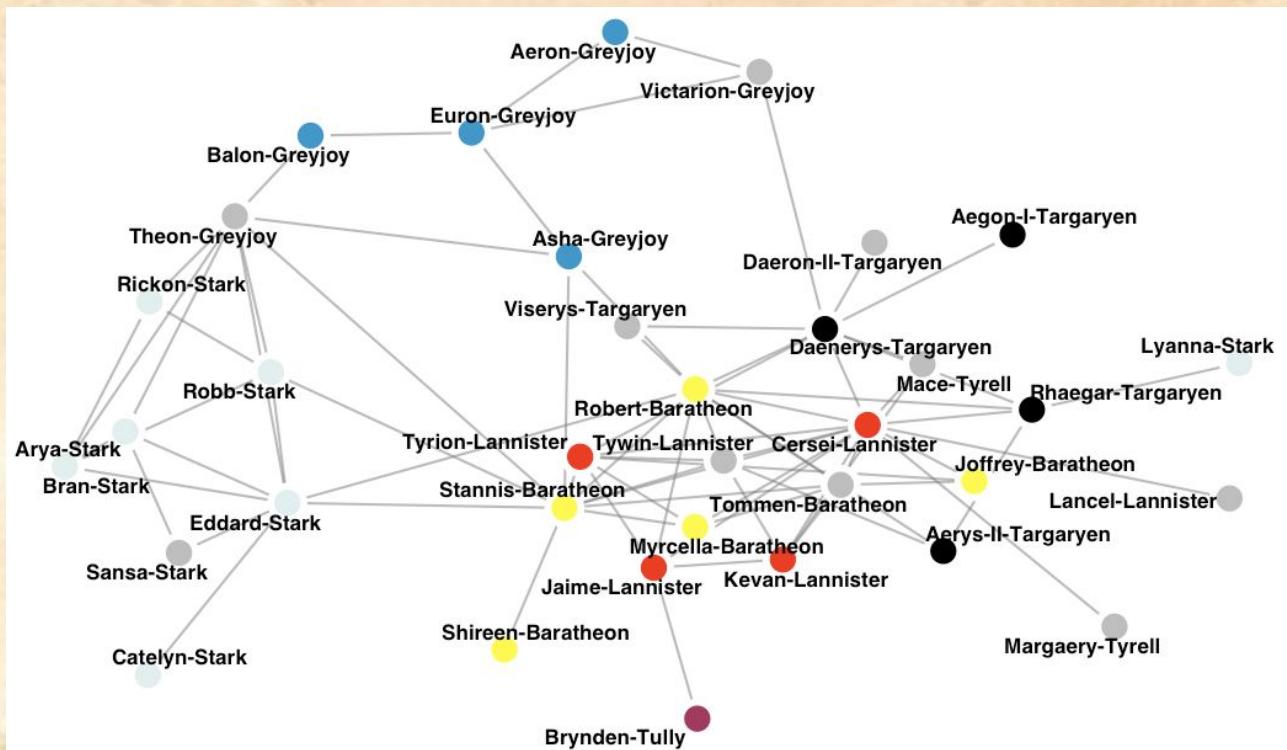
# Book 3



# Book 4

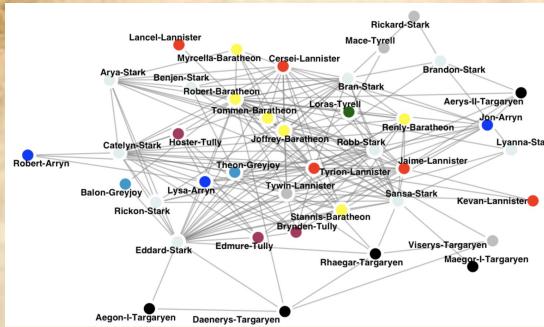


# Book 5

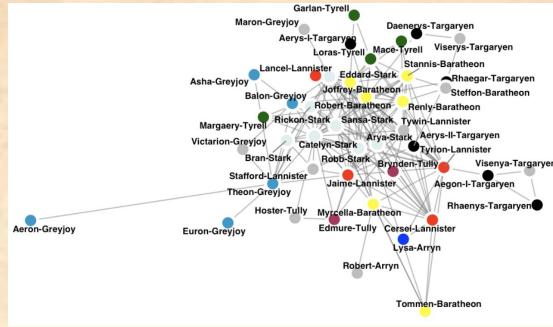


# Side by Side Comparisons

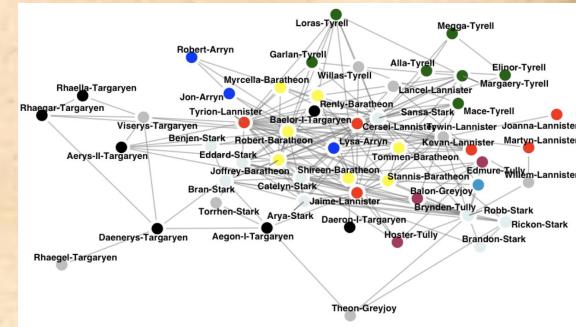
Book 1



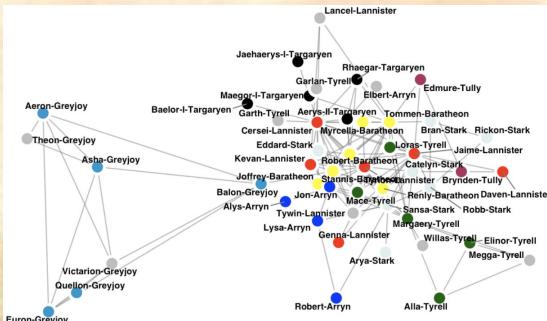
Book 2



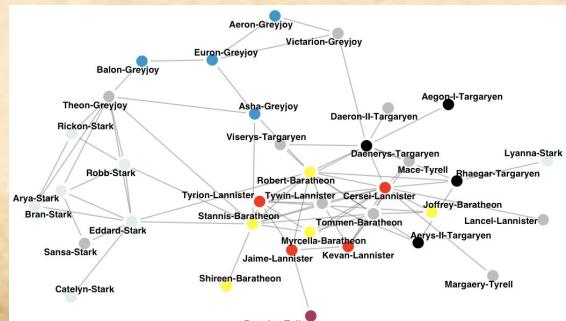
Book 3



Book 4



Book 5



# Degree Centralization

Book Number	Degree Centralization
Book 1	0.49
Book 2	0.18
Book 3	0.17
Book 4	0.22
Book 5	0.18

- Number of ties
- Book 1 focused on a single influential family
- House Stark = many connections
- Other books had more characters involved



# Closeness Centralization

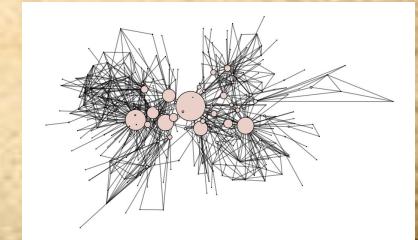
Book Number	Closeness Centralization
Book 1	0.52
Book 2	0.36
Book 3	0.34
Book 4	0.32
Book 5	0.33

- Inverse geodesic distance to all other nodes
- Book 1 focuses on Starks who can quickly reach other characters
- Vulnerability= removal of Starks disrupts communication flow

# Betweenness Centralization

Book Number	Betweenness Centralization
Book 1	0.24
Book 2	0.18
Book 3	0.22
Book 4	0.27
Book 5	0.45

- Number of shortest paths through node
- Books 1-4 have many characters that facilitate interaction
- Book 5 has few characters that facilitate connections between other characters, bottleneck exists



# Eigenvector Centralization

Book Number	Eigenvector Centralization
Book 1	0.6
Book 2	0.9
Book 3	0.9
Book 4	0.93
Book 5	0.92

- Influence of a node based on how influential its connections are
- Book 1 many characters have similar levels of influence (building story)
- Books 2-5 have few characters that hold significant influence (war)

Book #

# Degree Centrality

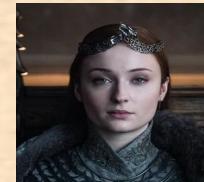
1



2



3



4



5



# Community / Cluster Detection

Louvain - uses iterative optimization

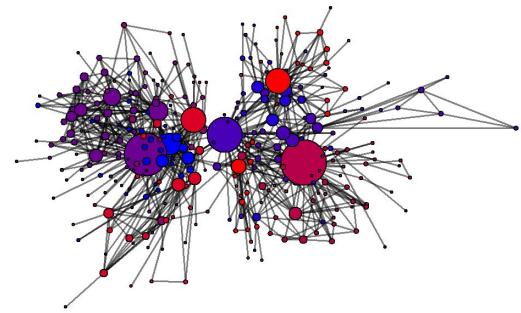
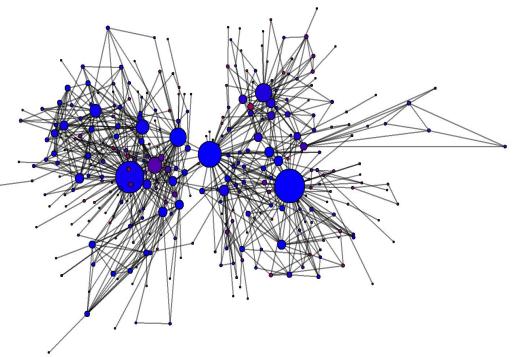
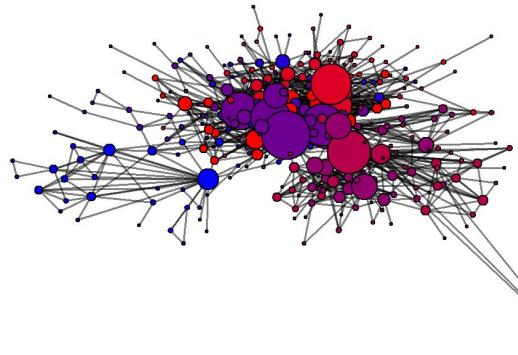
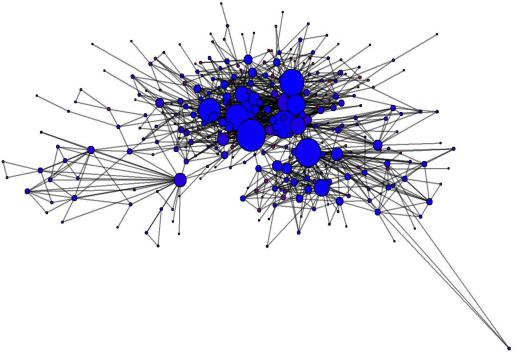
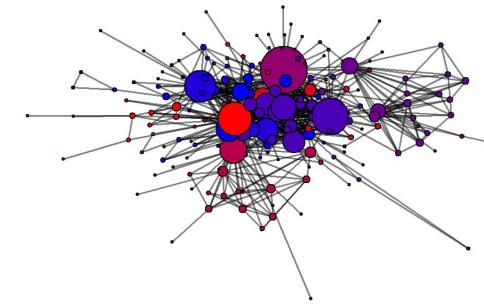
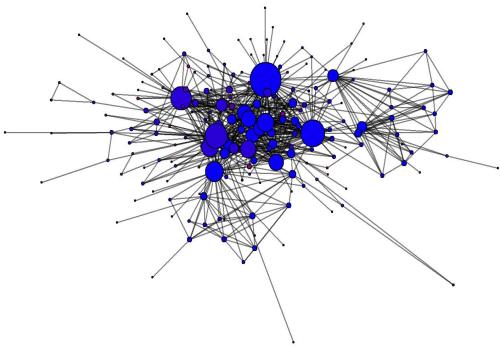
Fluid Cluster - preset number of clusters

Cluster Fast Greedy - hierarchical clustering



	Louvain	Fluid Cluster	Cluster Fast Greedy
Modularity	0.998	-	0.990
Length	70	8	186 (max)

# Louvain vs Fluid Cluster



# Louvain vs Fluid Cluster Communities

## Louvain

```
$`3`  
[1] "Aemon-Targaryen-(Maester-Aemon)" "Alliser-Thorne"  
[3] "Benjen-Stark" "Bowen-Marsh"  
[5] "Chett" "Donal-Noye"  
[7] "Dywen" "Grenn"  
[9] "Halder" "Jaremy-Rykker"  
[11] "Jeor-Mormont" "Jon-Snow"  
[13] "Pypar" "Rast"  
[15] "Samwell-Tarly" "Todder"
```



## Fluid Cluster

```
$`1`  
[1] "Benjen-Stark" "Brynden-Tully"  
[3] "Danwell-Frey" "Edmure-Tully"  
[5] "Galbart-Glover" "Hosteen-Frey"  
[7] "Hoster-Tully" "Jon-Umber-(Greatjon)"  
[9] "Lyn-Corbray" "Lysa-Arryn"  
[11] "Marq-Piper" "Robb-Stark"  
[13] "Robert-Arryn" "Roose-Bolton"  
[15] "Stevron-Frey" "Theon-Greyjoy"  
[17] "Tywin-Lannister" "Yoren"  
[19] "Mance-Rayder" "Stiv"  
[21] "Nestor-Royce" "Walder-Frey"  
[23] "Tytos-Blackwood" "Wendel-Manderly"  
[25] "Jared-Frey"
```

# Choosing a Model

Louvain has higher modularity than Cluster Greedy Fast

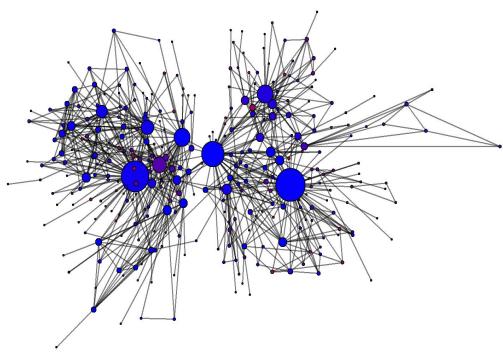
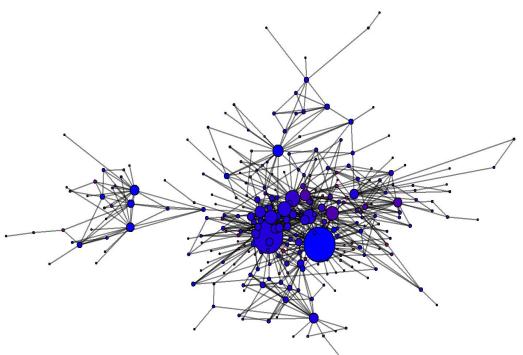
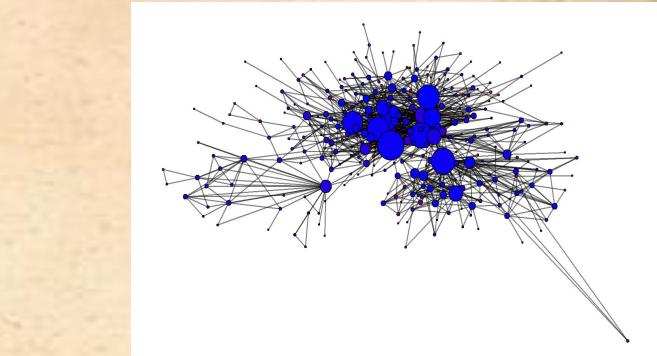
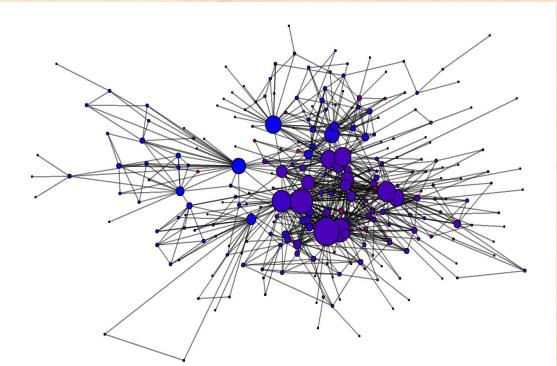
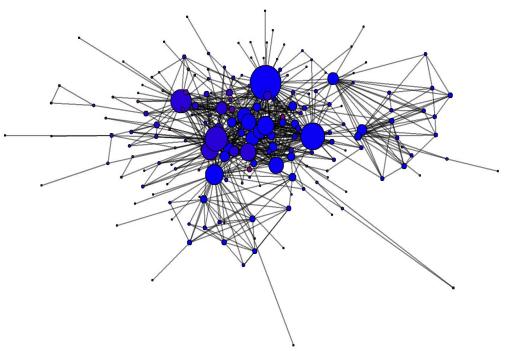
Louvain > Fluid Cluster as it shows unexpected relationship and is optimized for modularity.

Although depends what you are looking for.

Louvain	Modularity	Length (# of clusters)
GOT 1	0.998	70
GOT 2	0.998	80
GOT 3	0.998	93
GOT 4	0.999	86
GOT 5	0.999	95



# Louvain Models Books 1-5



# Book 4 - Louvain Community Sizes

Community sizes

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
18	2	13	14	5	3	11	4	1	20	6	9	25	1	3	6	3	12	4	1	4	3	1	1	1	14	3	1	1	1	1	2	3	2	1	3	2			
39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76		
1	2	2	3	2	3	2	2	2	2	1	1	2	5	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
77	78	79	80	81	82	83	84	85	86																														
1	1	1	1	1	1	1	1	1	1																														

8 clusters with more than 10 present (8 main houses)

Pattern throughout of a few clusters having a lot while most are one to two people.

# Cluster Takeaways

In GOT there is loyalty to the houses but the main loyalty is to one's self / immediate family.

Higher modularity when high number of clusters present.

- Lot of people do their own thing.
  - (makes sense story is all about alliances coming together and falling apart)



# ERGM

*Analysis for Final Model (lowest BIC) for each Book*

<b>Book #</b>	<b>Prob. Forming Tie</b>	<b>GOF? Degree not well</b>	<b>Model Ran Well?</b>
Book 1	5.19%	OK	Well
Book 2	5.34%	OK	Well
Book 3	6.05%	OK	Not Well
Book 4	8.35%	OK	Not Well
Book 5	6.39%	OK	Not Well

**Final Model:** edges (density), nodematch and nodefactor (homophily), gwesp (transitivity)

# Model Summary

	Estimate
edges	-6.40973
nodematch.Source.Family	0.99794
nodefactor.Source.Family.Baratheon	0.30246
nodefactor.Source.Family.Greyjoy	-0.22073
nodefactor.Source.Family.Lannister	0.19859
nodefactor.Source.Family.Stark	-0.10453
nodefactor.Source.Family.Targaryen	-0.24281
nodefactor.Source.Family.Tully	-0.14437
nodefactor.Source.Family.Tyrell	-0.05742
gwesp.fixed.0.5	2.77533

GOT<sub>1</sub>

	Estimate
edges	-5.92597
nodematch.Source.Family	1.03790
nodefactor.Source.Family.Baratheon	0.29134
nodefactor.Source.Family.Greyjoy	-0.18298
nodefactor.Source.Family.Lannister	0.18123
nodefactor.Source.Family.Stark	-0.15196
nodefactor.Source.Family.Targaryen	-0.37116
nodefactor.Source.Family.Tully	-0.09395
nodefactor.Source.Family.Tyrell	-0.06823
gwesp.fixed.0.5	2.54165

GOT<sub>2</sub>

	Estimate
edges	-6.16682
nodematch.Source.Family	1.02412
nodefactor.Source.Family.Baratheon	0.29099
nodefactor.Source.Family.Greyjoy	-0.17268
nodefactor.Source.Family.Lannister	0.14537
nodefactor.Source.Family.Stark	-0.17243
nodefactor.Source.Family.Targaryen	-0.25870
nodefactor.Source.Family.Tully	-0.08068
nodefactor.Source.Family.Tyrell	-0.15931
gwesp.fixed.0.5	2.67528

GOT<sub>3</sub>

# Model Summary cont.

	Estimate
edges	-6.18263
nodematch.Source.Family	0.99947
nodefactor.Source.Family.Baratheon	0.36811
nodefactor.Source.Family.Greyjoy	-0.08673
nodefactor.Source.Family.Lannister	0.22482
nodefactor.Source.Family.Stark	-0.06764
nodefactor.Source.Family.Targaryen	-0.28131
nodefactor.Source.Family.Tully	-0.06239
nodefactor.Source.Family.Tyrell	0.09053
gwesp.fixed.0.5	2.60244

GOT<sub>4</sub>

	Estimate
edges	-6.21466
nodematch.Source.Family	0.98467
nodefactor.Source.Family.Baratheon	0.31570
nodefactor.Source.Family.Greyjoy	-0.16568
nodefactor.Source.Family.Lannister	0.15695
nodefactor.Source.Family.Stark	-0.11699
nodefactor.Source.Family.Targaryen	-0.29129
nodefactor.Source.Family.Tully	-0.01291
nodefactor.Source.Family.Tyrell	-0.02553
gwesp.fixed.0.5	2.68453

GOT<sub>5</sub>

**Edges:** Ties are quite unlikely to form, indicating a sparse network structure

**Nodematch:** Strong tendency for nodes within the same family to connect (homophily)

**GWESP (Transitivity):** Notable tendency for clustering within the network. Transitivity (friends of friends becoming friends) is a significant feature of the network

# Further Questions

- Apply various weights to self loops specific to characters
- Get a better understanding of their true influence
- Run war simulations through contagion models
- Filter out historic figure characters (lot of storytelling about historical figures in the books)



# Conclusion



- Network visualizations follow story of the books
- Tyrion Lannister is most influential character (Top 5 in degree centrality throughout all books)
- True loyalty of people is with themselves, not always with the house
- Ties in general unlikely to form
- Characters within the same family much more likely to connect
- Strong evidence of clustering and transitivity (friends of friends becoming friends)

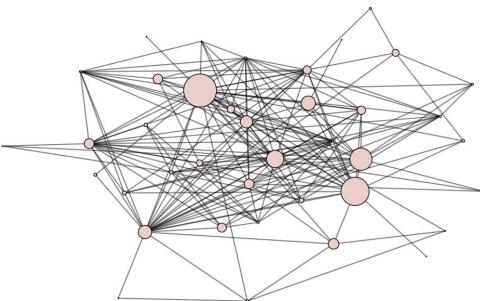
**Implications:** can be tied to understand complex relationships and how people may act during a war

A scene from the television show Game of Thrones. In the foreground, two large, green and gold-colored dragons are resting on a grassy hillside. In the middle ground, Daenerys Targaryen, played by Emilia Clarke, stands in white armor next to one of the dragons. In the background, a massive stone castle with many towers rises against a clear blue sky.

Questions?  
Thank you!

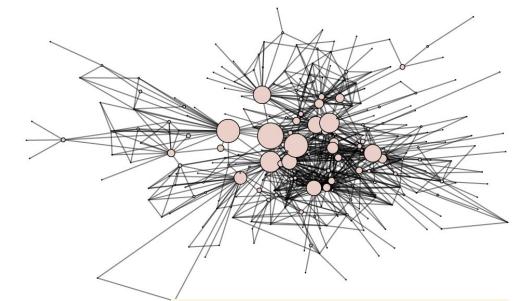
# Appendix- Betweenness

Book 1



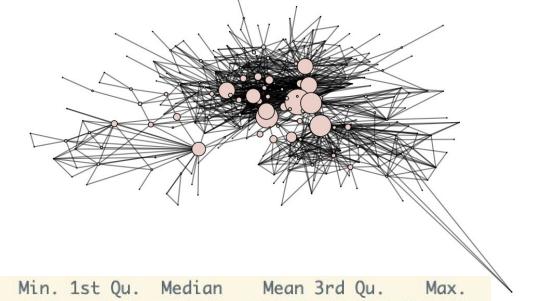
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Book 2



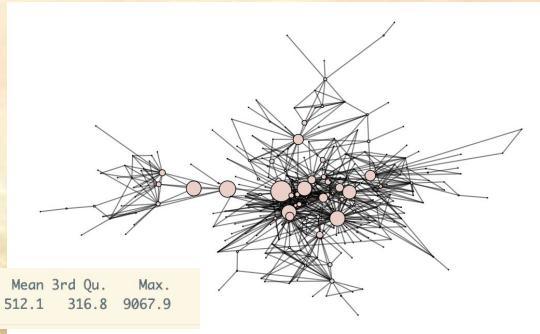
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Book 3



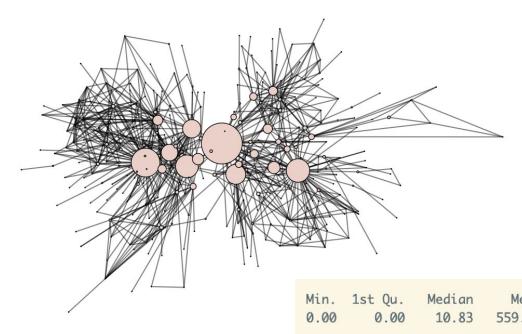
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Book 4



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Book 5



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