

Searching for hidden bridges in co-occurrence networks from Javanese *wayang kulit*

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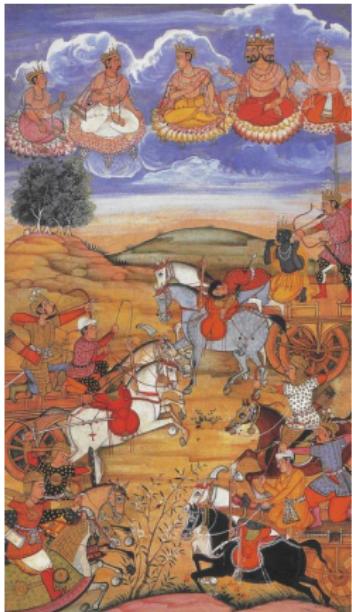
October 18, 2019

Javanese *wayang kulit*

Wayang = shadow
kulit = skin (leather)



Social complexity in the **Mahabharata**



https://www.ancient.eu/Bhagavad_Gita/ https://en.wikipedia.org/wiki/Kurukshetra_War

Social complexity in Javanese *wayang* **Mahabharata**



<https://www.bonculturite.com/faised-pandava-lisa-51162>

The **Pandawa** :

Sons of Pandu. Heroes.



<https://wayanggaleri.wordpress.com/2015/06/01/kurawa/>

The **Korawa** :

Rivals.



<https://pageubahanbadutoto.wordpress.com/2016/06/31/kawula-guru-dan-punokawan-dalam-wayangan/>

The **Punokawan**:

Characters from **Javanese** mythology, assimilated into the epic

Historical complexity in Javanese wayang Mahabharata



<https://www.youtube.com/watch?v=j1GnZ9qovWE>

Javanese *wayang* adds new characters and stories, reflecting the evolution of the surrounding culture.

Wayang kulit practice varies over ...

- **Space:**

Regional traditions

- **Time:**

When/how were new elements added?

carangan vs. *pokok*
("branch" vs. "trunk")

- **Cultural context:**

individual style,
current events



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Each telling emphasizes different characters and events.

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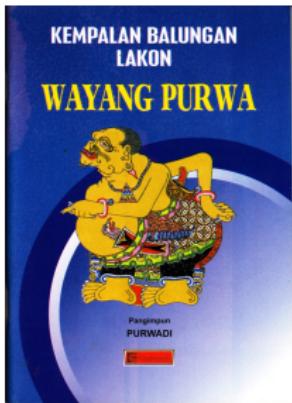
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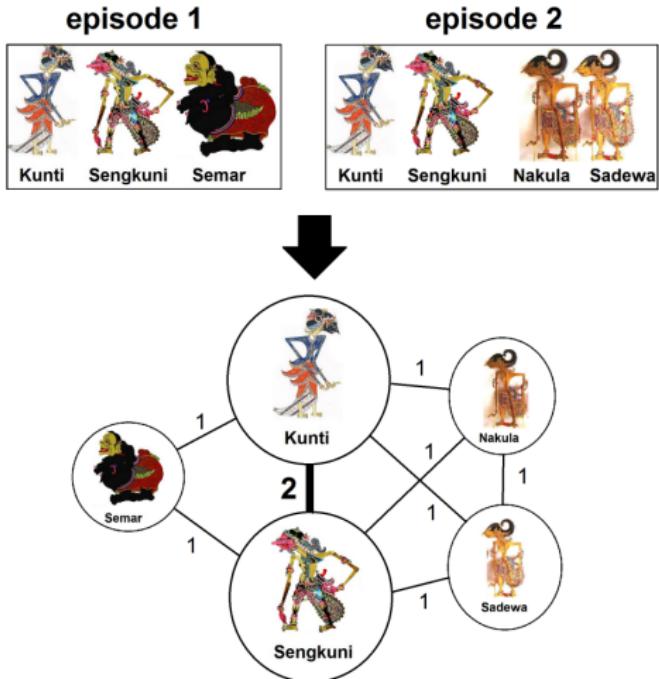
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These variations may be captured using **co-occurrence networks**.

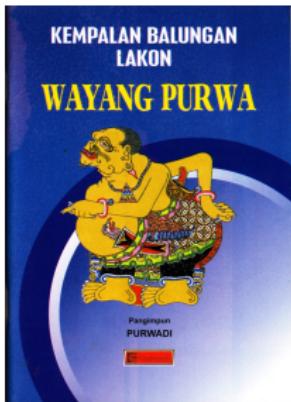
Wayang kulit co-occurrence networks



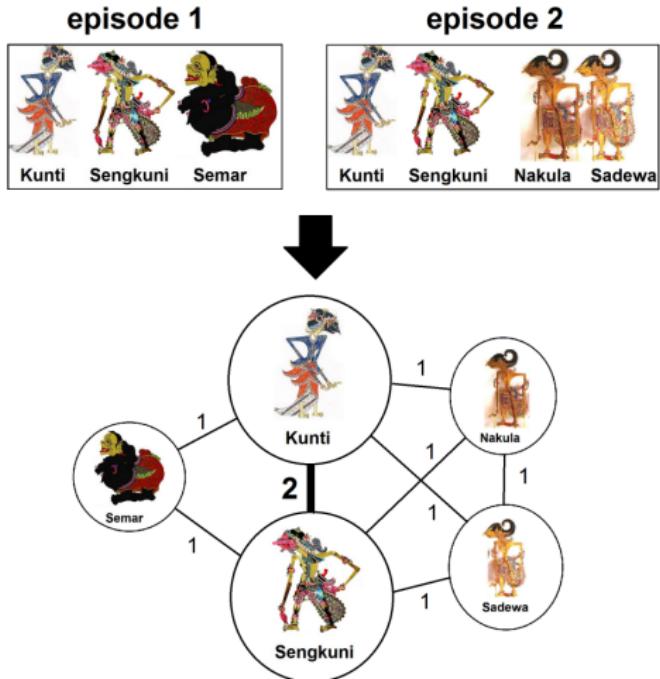
Compilation of
plot summaries



Wayang kulit co-occurrence networks



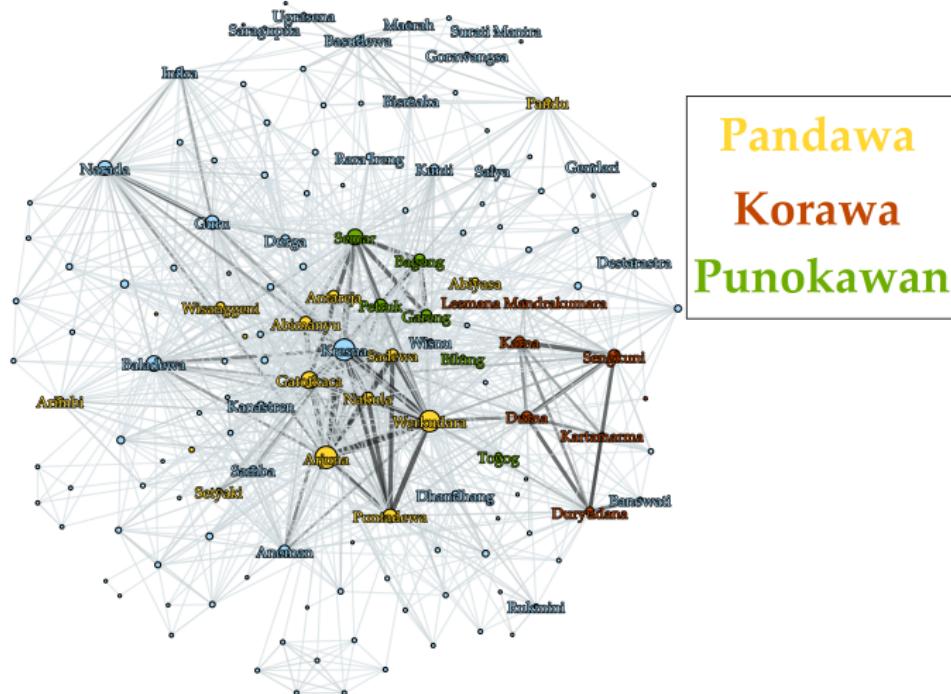
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Which characters play unique structural roles?

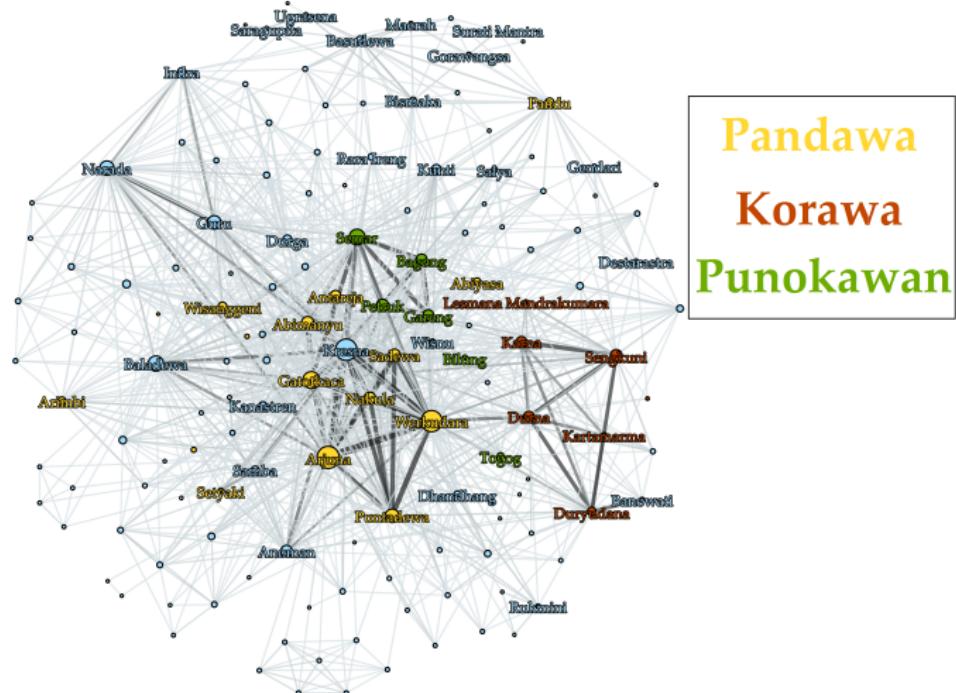
Character co-occurrence network

Scene-based co-occurrence window



Character co-occurrence network

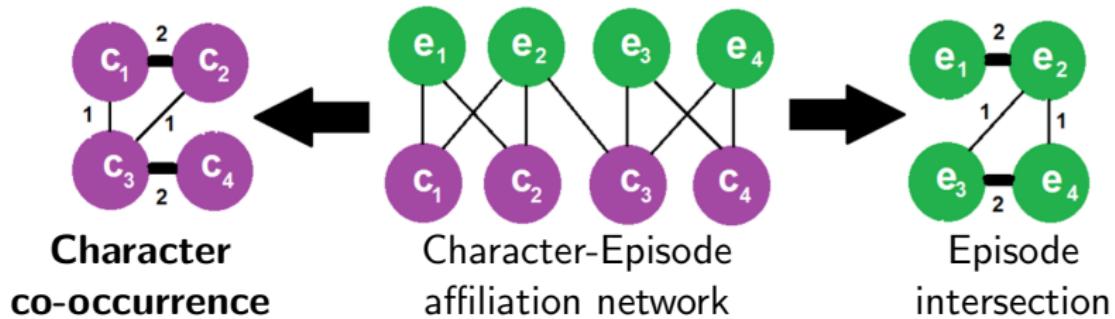
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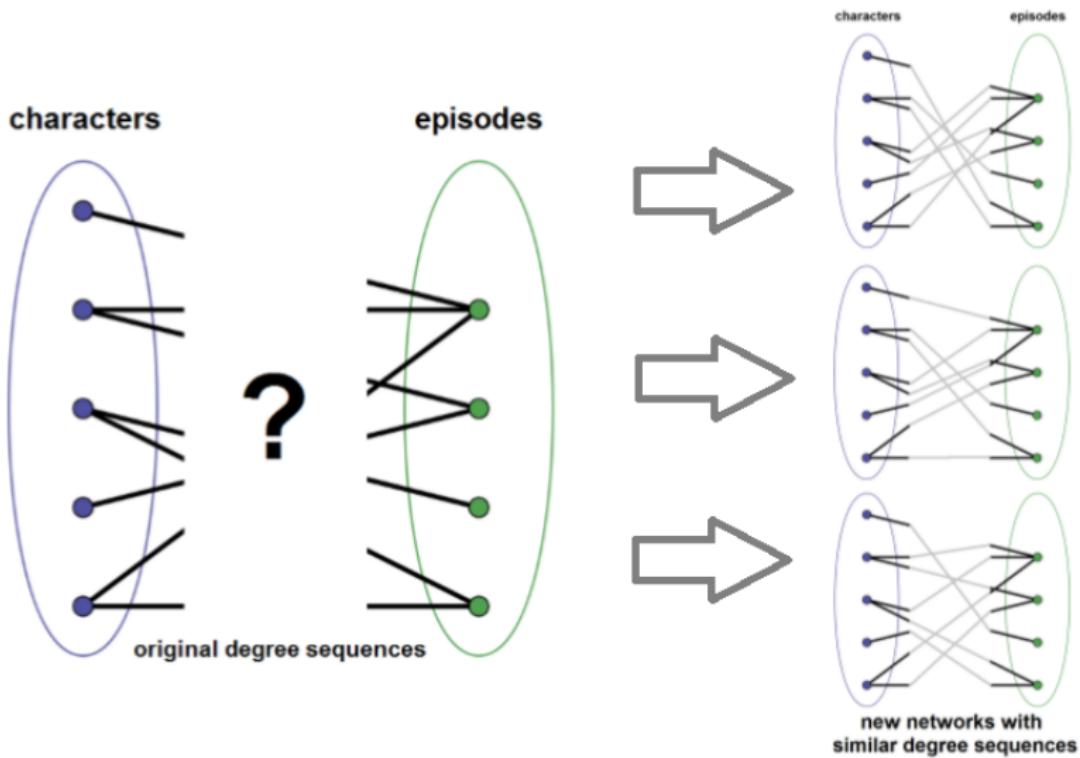
Which characters play unique structural roles?

Affiliation networks → Co-occurrence networks

Weighted projections of bipartite networks

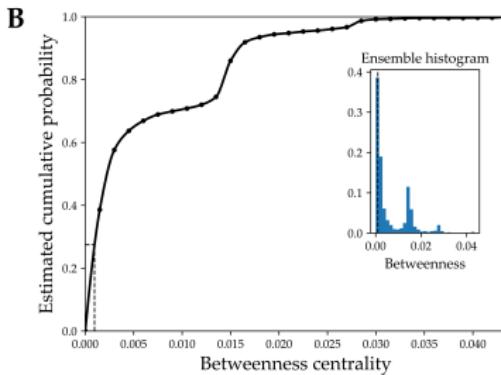
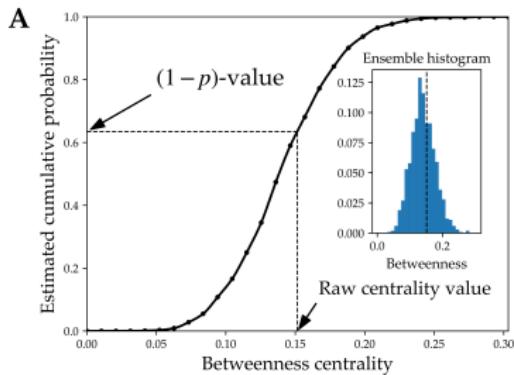


Ensemble null model



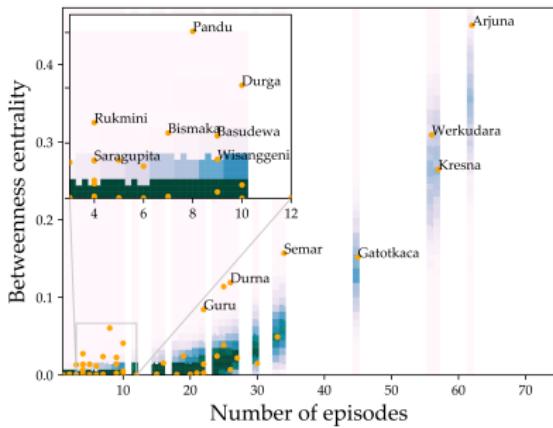
Re-ranking nodes by deviation from null model

Character betweenness centrality “ p -values”:

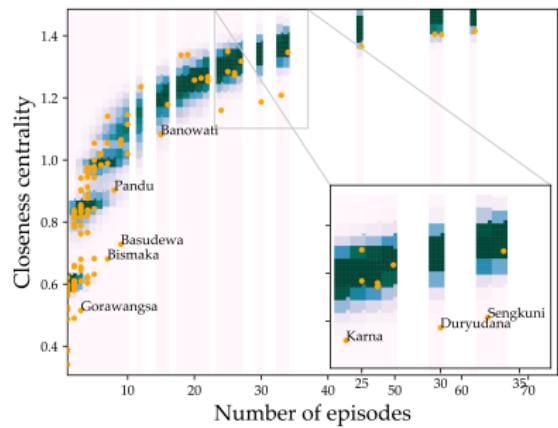


How do nodes deviate from the null model?

Betweenness

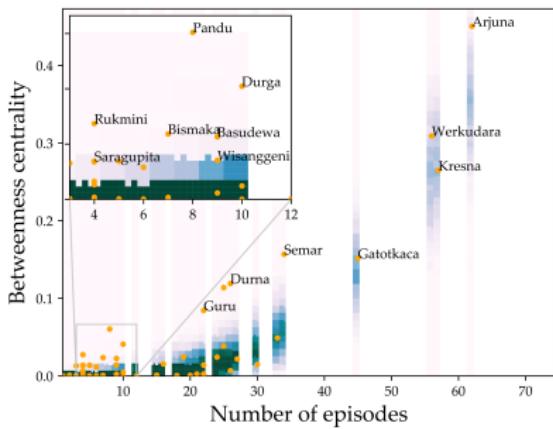


Closeness

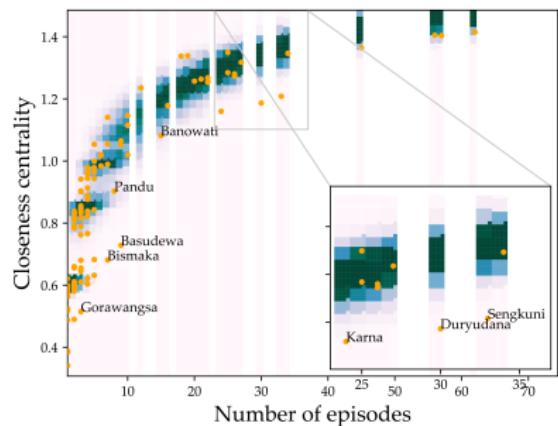


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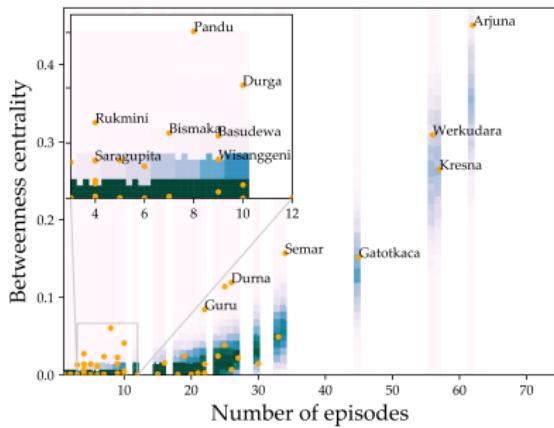
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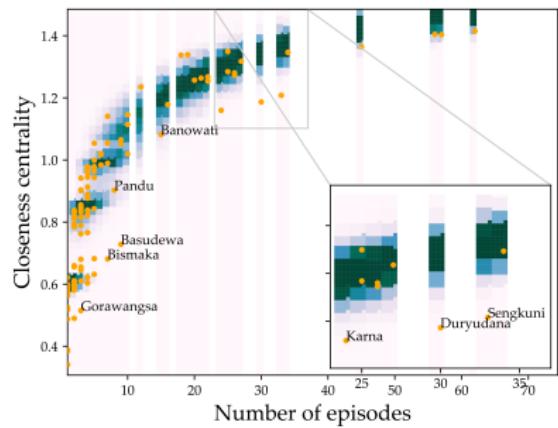
High-betweenness outliers are often **female characters**

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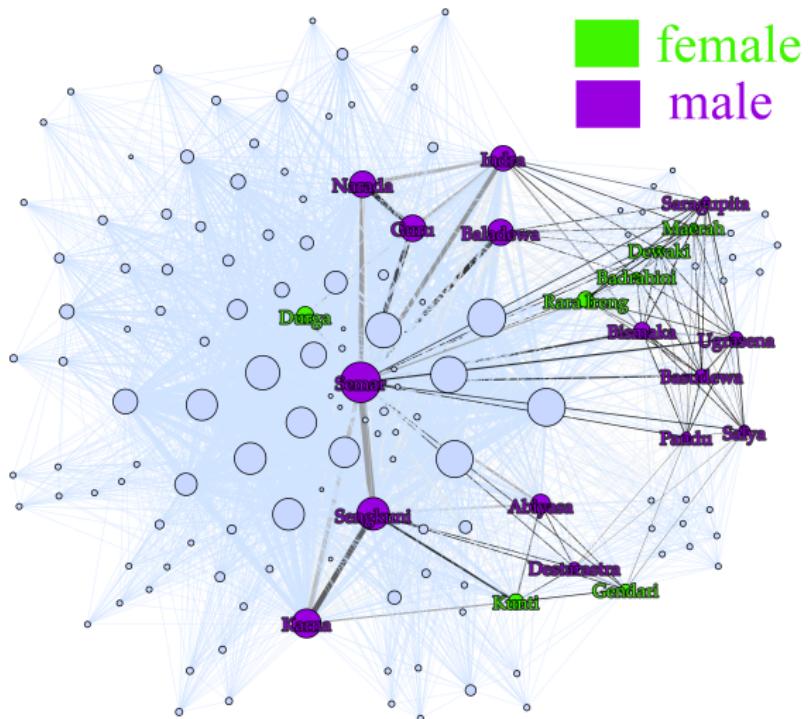


High-betweenness outliers are often **female characters**

Low-closeness outliers are the **antagonists' faction**

1. Female characters often form hidden “bridges”

Network constructed using story-based co-occurrence window



1. Female character nodes often form hidden “bridges”

Durga



<http://blog.hadisukirno.co.id/betari-durga/>

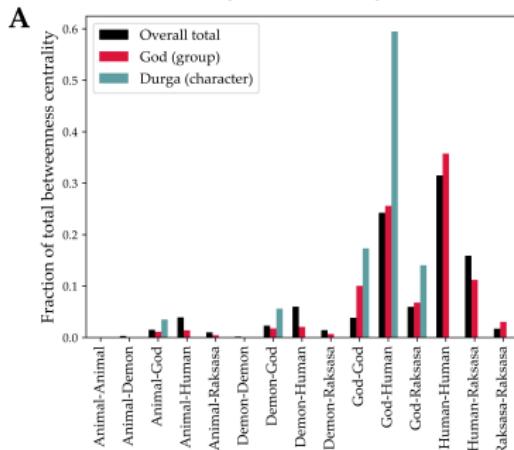
Rukmini



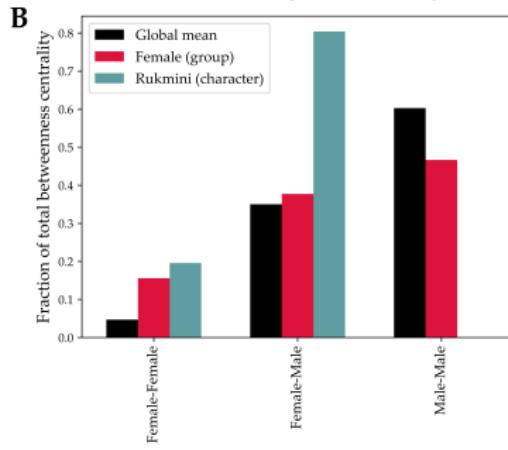
[http://lakon-wayang-ku.blogspot.com/2011/02/
alap-alapan-rukmini.html](http://lakon-wayang-ku.blogspot.com/2011/02/alap-alapan-rukmini.html)

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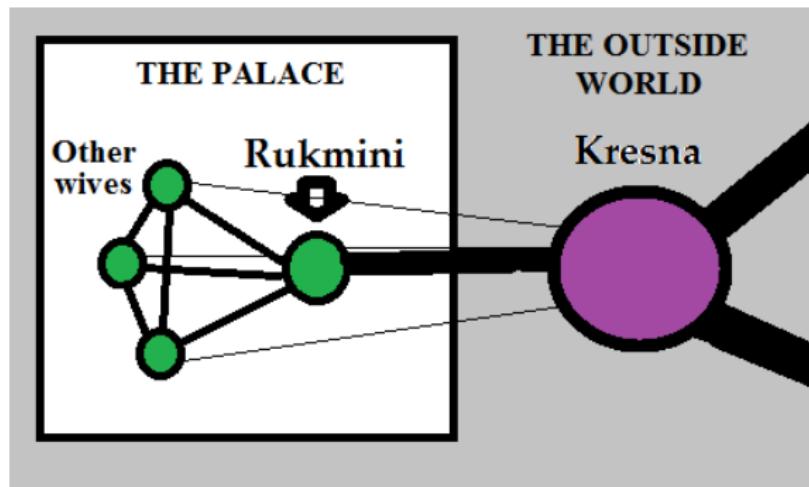
Durga (Species)



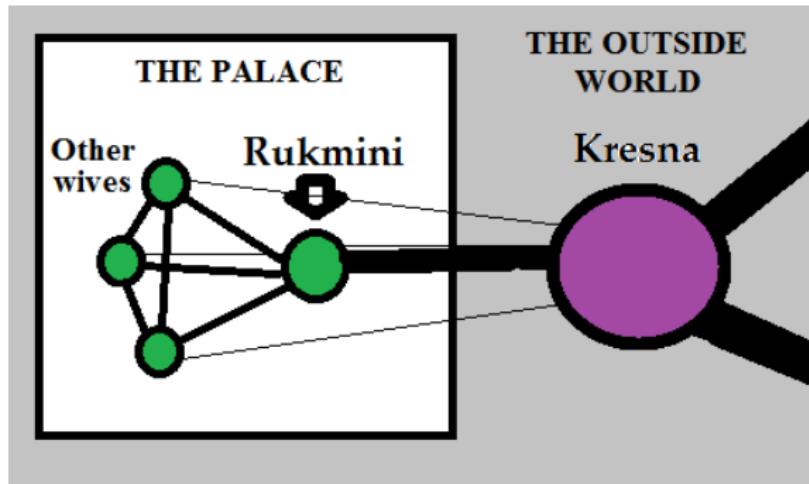
Rukmini (Gender)



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Unique social roles are reflected in co-occurrence patterns.

2. How integral are Javanese characters?

Are **Java** characters more peripheral than **India** characters?

Faction	Mean degree	Mean node strength	Mean closeness	Mean p-value (C.C.)
Female	3.77	15.35	.779	.5406
Male	7.96	38.5	.833	.6061
<i>Korawa</i>	18.71	69.29	1.081	.7211
<i>Pandawa</i>	19.38	105.68	1.127	.5005
<i>Punokawan</i>	17.83	101.83	1.096	.6826
Unaffiliated	4.14	18.09	.750	.5924
India	9.96	46.64	.893	.5918
Java	4.01	19.8	.746	.5926

Low-closeness outlier factions are structurally isolated.

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Java characters have lower degree/closeness ...

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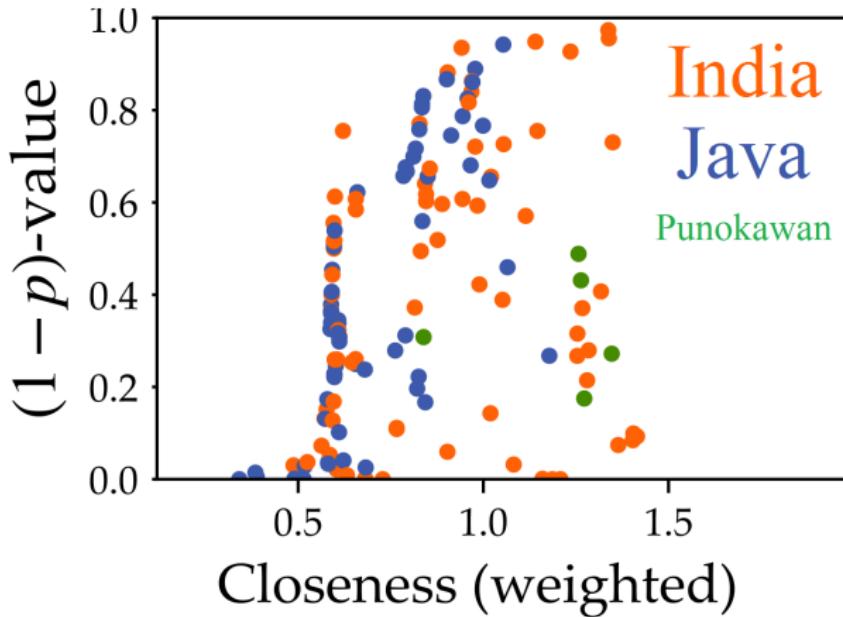
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Java characters have lower degree/closeness . . .
but nearly **identical p-values** to India characters.

2. How integral are Javanese characters?

Are Java characters more peripheral than India characters?



These p -values are also distributed throughout a similar range.

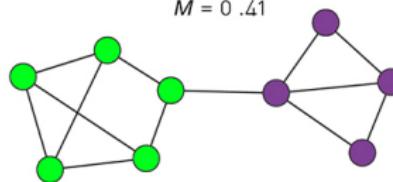
Review: Modularity

Modularity measures how well node labels match communities.

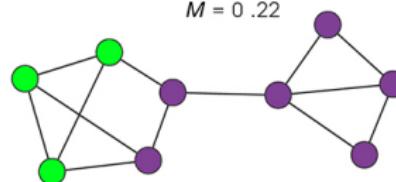
⇒ Do characters tend to co-occur based on shared label?

*Recall community detection algorithms used **modularity maximization** to produce labels that reflect network structure.*

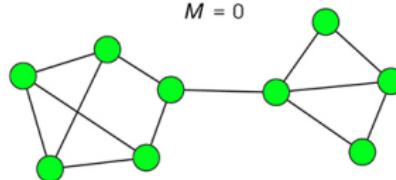
a. OPTIMAL PARTITION
 $M = 0.41$



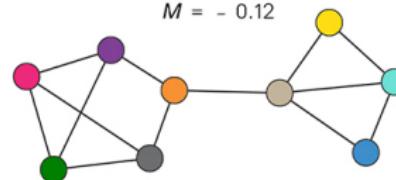
b. SUBOPTIMAL PARTITION
 $M = 0.22$



c. SINGLE COMMUNITY
 $M = 0$



d. NEGATIVE MODULARITY
 $M = -0.12$



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Javanese elements are called “branches” from the epic’s “trunk”.

Do they actually form detached co-occurrence “branches”?

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Network metric	Empirical network	Rewired mean
Number of links $\ L\ $	1032	1032
Largest component	146	146
Diameter	5	3.78
Mean shortest path	1.34	1.28
Density (topological)	.10	.14
Mean clustering coeff.	.72	.38
<i>Species</i> modularity	.08	-.006
<i>Origin</i> modularity	.06	-.006
<i>Tribe</i> modularity	.17	-.017
<i>Gender</i> modularity	.01	-.001

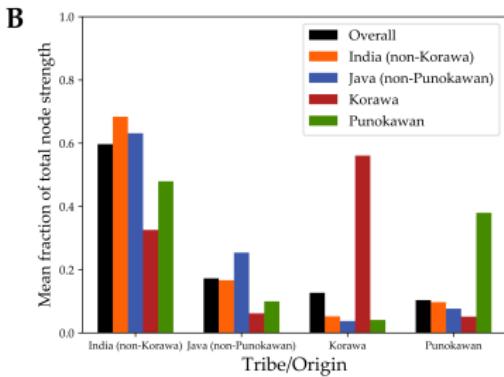
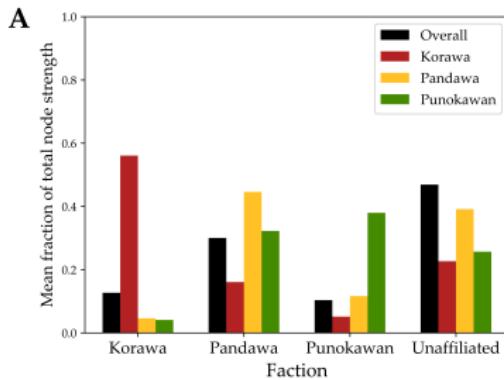
⇒ Yes, apparently they do . . .

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... but that appears to be explained by Tribe clustering

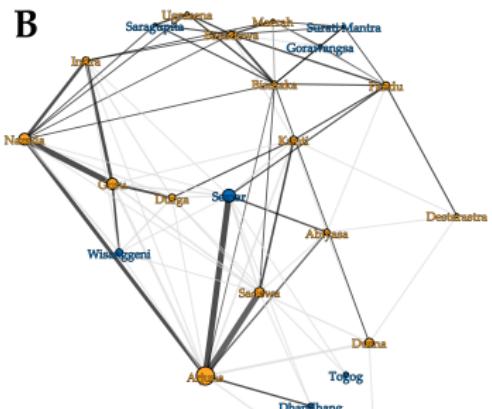
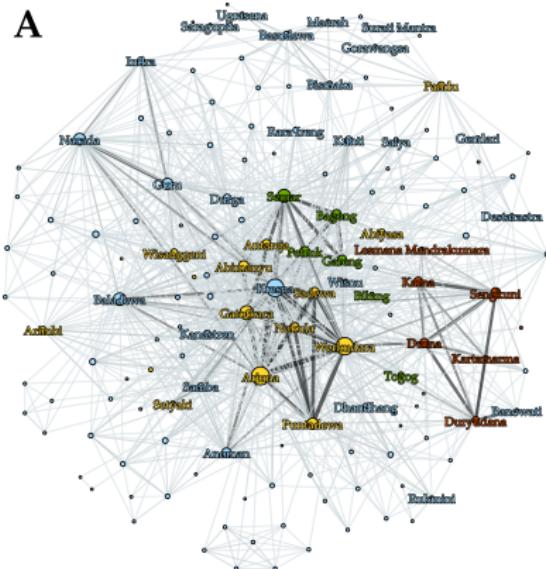
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(High-betweenness outliers only)



India
Java

Recap

- High-betweenness outliers from ensemble null model reveal social divisions and intermediary roles that can enrich future comparative studies
- Javanese characters have come to be as deeply-embedded in the network as Indian-canonical characters, when their degrees are considered

Ongoing work

- Comparison with serial TV versions of *Mahabharata*

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- Do network features reflects cultural context, medium of presentation, . . . ?
- Application to often-retold episodic fiction (comics, films)
- Other generative models (e.g. Social Balance Theory) as “null models”

Questions?

Contact: andrew.schauf@ntu.edu.sg

Paper:

Schauf, A. J., & Escobar Varela, M. (2018). Searching for hidden bridges in co-occurrence networks from Javanese wayang kulit. *Journal of Historical Network Research*, 2(1), 26-52.

▶ Link

Digital Wayang Encyclopedia:

<https://villaorlado.github.io/wayangnetworks/html/>

▶ Link

Escobar Varela, M. (2019). Towards a digital, data-driven wayang kulit encyclopedia: Histories, experiments and epistemological reflections. *Indonesia and the Malay World*, 47(137), 23-46.