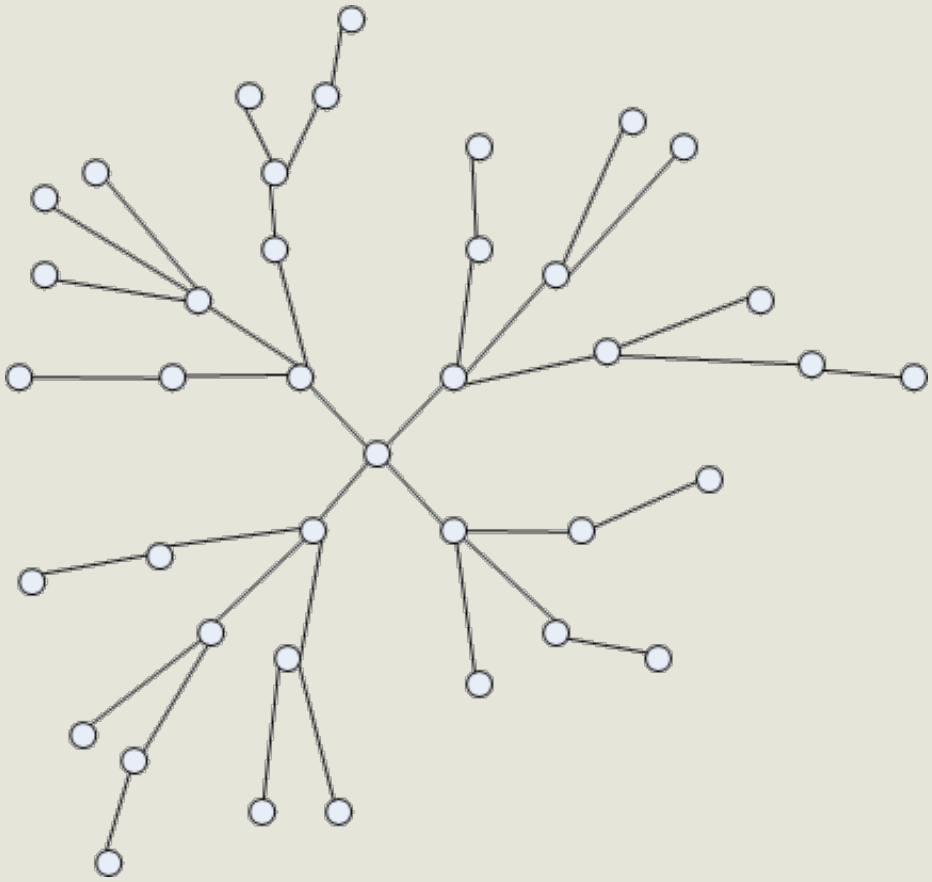
UNIVERSAL PROPERTIES OF MYTHOLOGICAL NETWORKS

Roopa Krishnaswamy
Jamie Fitzgerald
Manuel Villegas
Riqu Huang
Riley Neal

INTRODUCTION

- What are networks?
- Universality



SCIENTIFIC DESCRIPTION

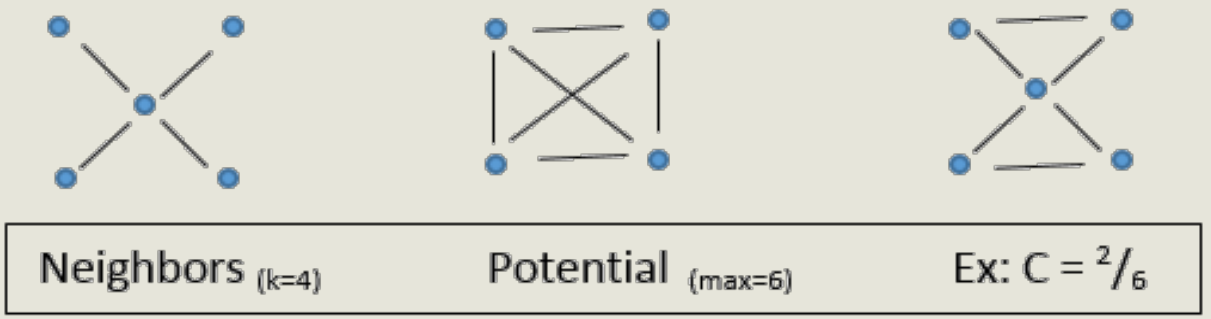
- Network tree diagrams
- Comparative mythology
- Tools for analysis

PARAMETERS & MODEL

- Clustering Coefficient
- Hierarchical networks
- Degree distribution/scale-free networks
- Giant component
- Betweenness centrality
- Assortativity
- Triads
- Structural balance
- Targeted and random attacks

CLUSTERING COEFFICIENT (C_I, C)

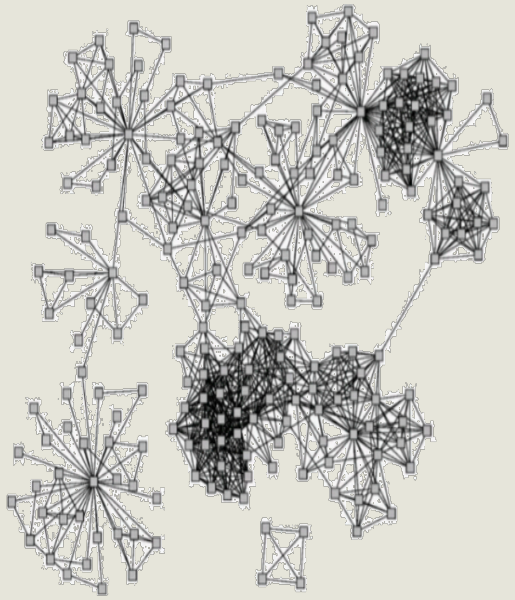
- Density of neighbor connections of node
  - Given as percentage of actual over potential ($C_i \in [0, 1]$)
- Potential connections: max = $k_i(k_i-1)/2$
  - Where k_i is the number of neighbors of i^{th}-node ("degree")
  - Actual number, n_i divided by maximum: $C_i = 2n_i/k_i(k_i-1)$
- Global average yields probability two neighbors of a node are connected ("transitivity")



HIERARCHICAL NETWORKS

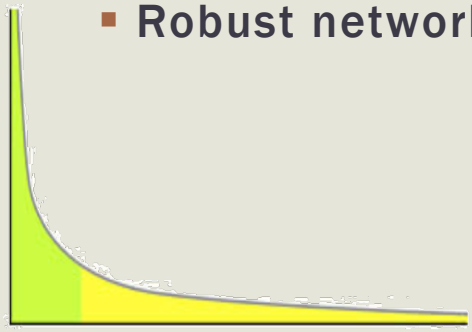
- Type of complex networks in which increasingly large groups form modular structures
- Clustering Coefficient is power-law dependent on node degree
  - C(k) ~ 1/k
  - Predominately low- degree nodes
  - Few high-degree structural nodes
  - Indicates dense sub-graphs

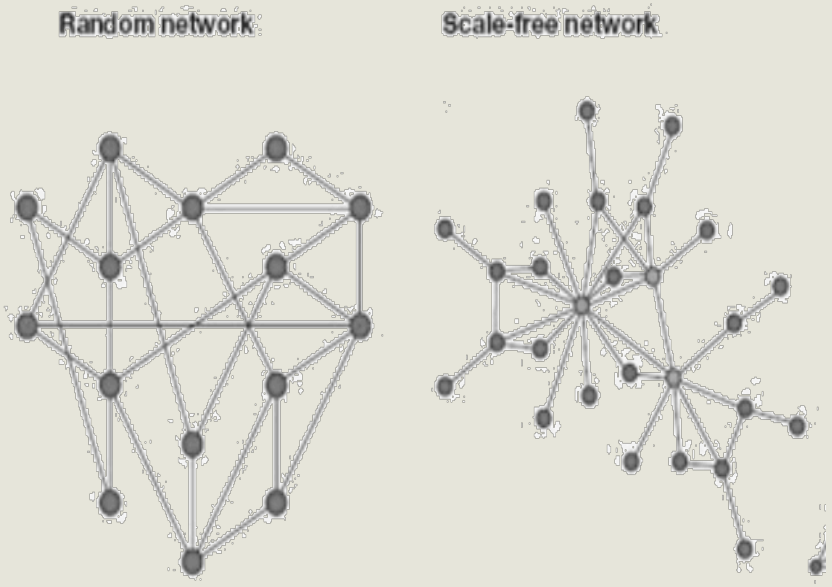
    of low-degree nodes



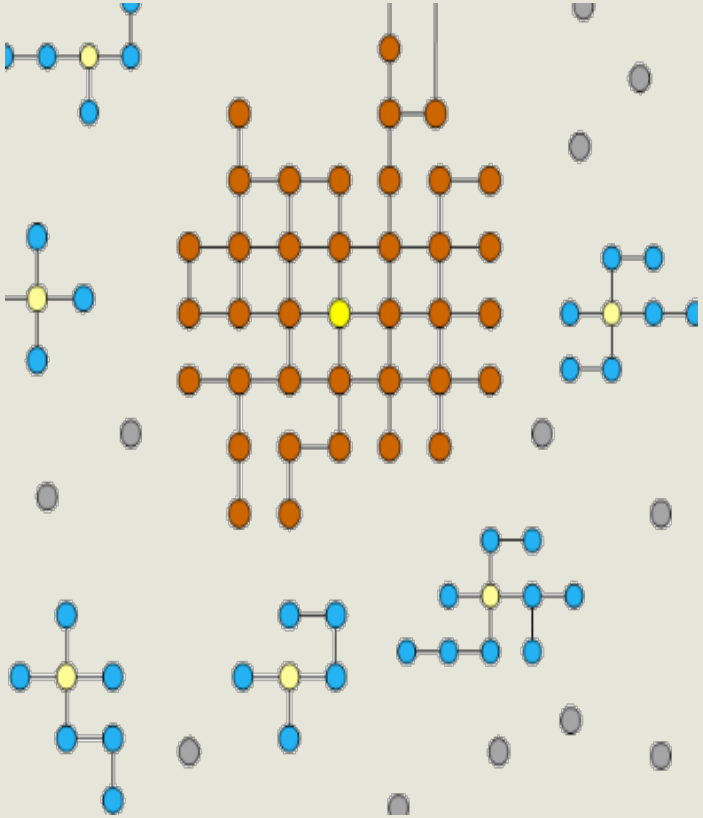
DEGREE DISTRIBUTION/SCALE-FREE NETWORKS

- Probabilistic distribution for degrees of each node
- Frequently:
  - $p(k) \sim k^{-\gamma}$ ← "probability that a node has degree, k"
  - for $\gamma > 0$
- Scale-Free Network Characteristics
  - Relatively small geodesics
  - Power-Law distribution
  - Large hubs supported by lesser node connections
  - Robust networks





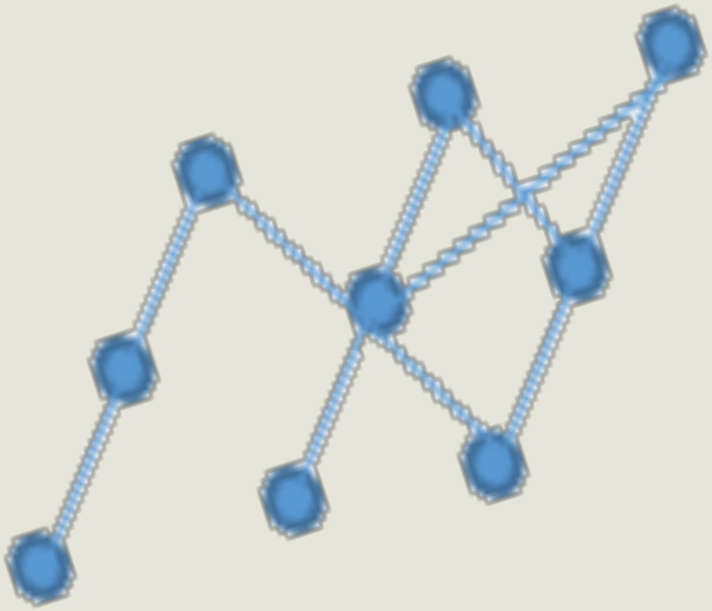
GIANT COMPONENT



- Connected components: linked sections of any network
- Giant component is the largest of these
  - Size being a measure of connectivity of the network
- Scale-Free Networks: removing influential nodes collapses Giant Component
  - removing random nodes leaves intact

BETWEENNESS CENTRALITY (G_L)

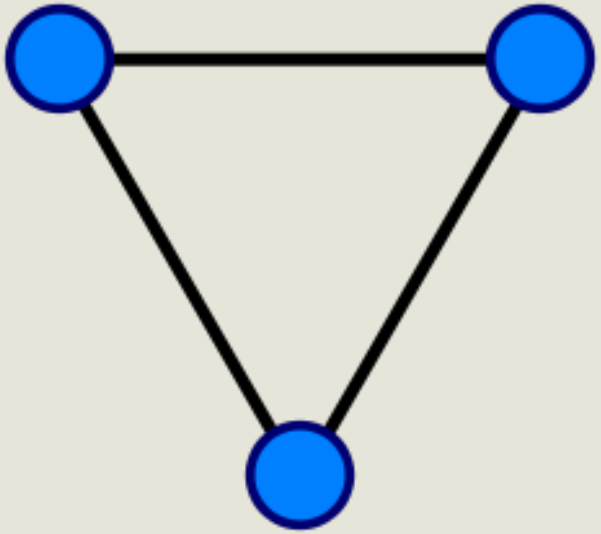
- Measure of network connectivity – influence of nodes in terms of flow
- Percentage of geodesics through a node
  - $$g_l = \frac{2}{(N-1)(N-2)} \sum_{i \neq j} \frac{\sigma_l(i,j)}{\sigma(i,j)}.$$



ASSORTATIVITY COEFFICIENT (R)

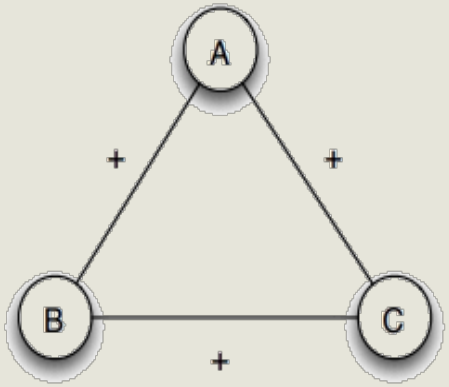
- The assortativity coefficient is the Pearson correlation coefficient of degree between pairs of linked nodes
  - $r = \frac{\sum_{jk} jk(e_{jk} - q_j q_k)}{\sigma_q^2}$

CLOSED TRIADS

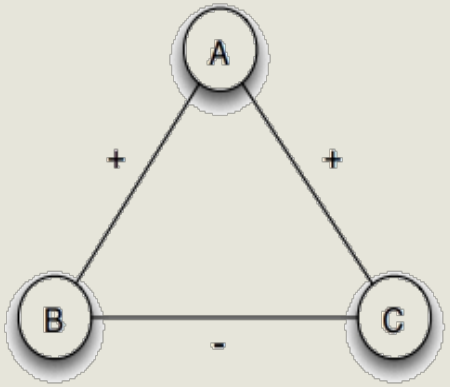
- 

STRUCTURAL BALANCE

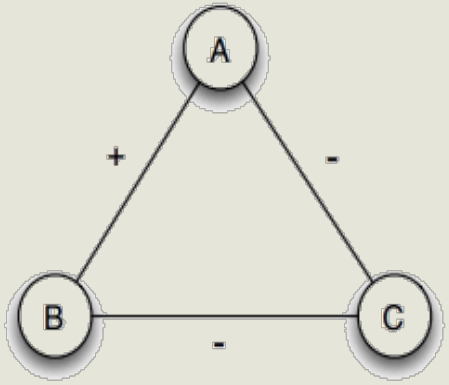
- Friendly/Hostile



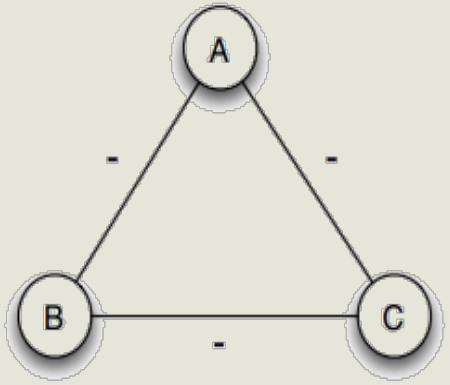
(a) *A, B, and C are mutual friends: balanced.*



(b) *A is friends with B and C, but they don't get along with each other: not balanced.*



(c) *A and B are friends with C as a mutual enemy: balanced.*



(d) *A, B, and C are mutual enemies: not balanced.*

PARAMETERS & MODEL

- Targeted attack
- Random attack
- Robustness
- Vulnerability

RESULTS

- All 7 networks are similar to real social networks
- Can determine the difference between fictional networks and real social networks

	Social	Myth (friendly)	Fiction
Small world	Yes	Yes	Yes
Hierarchy	Yes	Yes	Yes
$p(k)$	Power law	Power law	Exp.
Scale free	Yes	Yes	No
G_c	$< 90\%$	$< 90\%$	$> 90\%$
TA	Vulnerable	Vulnerable	Robust
RA	Robust	Robust	Robust
Assortative	Yes	Yes	No

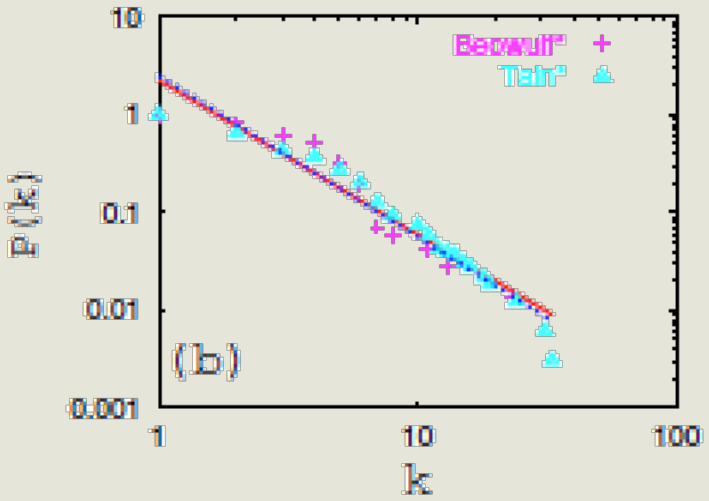
RESULTS

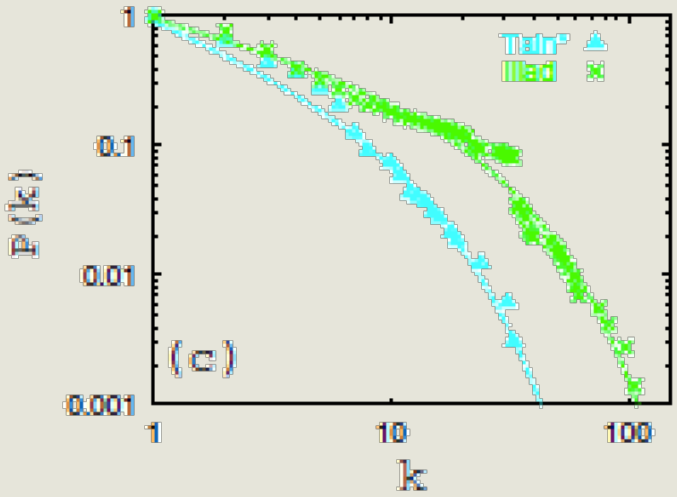
	Social	Fiction	Iliad	Beowulf	Tain
Small world	Yes	Yes	Yes	Yes	Yes
Hierarchy	Yes	Yes	Yes	Yes	Yes
p(*k*)	Power law	Exponential			
Scale Free	Yes	No			
Gc	<90%	>90%	>90%	<90%	>90%
TA	Vulnerable	Robust	Vulnerable		
RA	Robust	Robust			
Assortative	Yes	No	Yes	No	No

- Iliad most similar to a real social network
- Beowulf is a mix of reality and fiction
  - Remove main character ➔assortative
- Táin is fictitious

RESULTS - TÁIN

- When compared to Beowulf a similarity was recognized
- Similar to the distribution of the Iliad





- The top six characters are most likely amalgams

IN CONCLUSION…

- Examined the networks of 3 mythological stories
- Analyzed all of the networks for universal parameters
- Compared to 4 fictitious stories

FUTURE WORK

- TV shows
- Ghost writers in songs
- Political networks