Network Theory: Universal Properties of Television Shows

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Project Description
- In this project, the first season of five television programs were analyzed using network theory and universal properties described by Carron and Kenna [1]. Each show's network is comprised of every character-to-character interaction, which was then graphed and analyzed. The properties of the networks were compared to those of purely fictional networks and nonfictional social networks. The analysis reveals whether or not the social networks found in the television shows resemble real-life social networks.

Scientific Challenges
- Challenges associated with the project were the limited portion of the network presented in an episode of a television show, limited data, and the qualifying of character interactions into "meaningful" and otherwise.

Potential Applications
- In the context of television, one can determine whether "historical" shows are in fact representative of real life networks.
- One of the many applications of applied network theory is uprooting corrupted law enforcement based on the network of arrest patterns.
- Additionally, this type of network theory could be used to trace lobbyist money to certain pieces of legislation and the congressmen who sponsor them.

Methodology
1. Collected the character-to-character interaction from the first season of five different TV shows; The Tudors, House of Cards, Keeping Up With The Kardashians, Cops, and Deadbeat.
2. Used NetworkX in Python to develop individual networks.
3. Analyzed each network using the universal properties described by Carron and Kenna [1].
   Universal Properties Examined:
   - Average path length
   - Small World
   - Hierarchical Network
   - Degree Distribution
   - Clustering Coefficient
   - Giant Component
   - Assortativity Coefficient
   - Structural balance
   - Target Attack
   - Betweenness Centrality
4. Based upon the data calculated we were able to determine whether or not each network was a fictional or real social network.
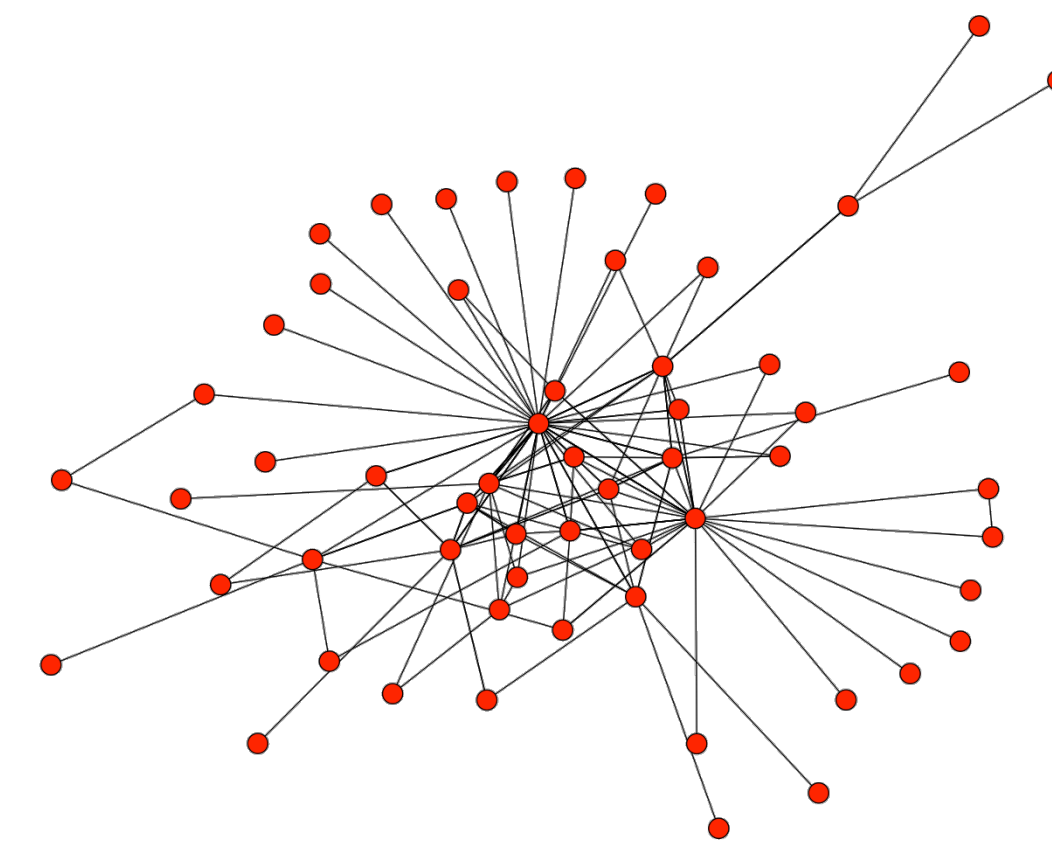
Acknowledgments
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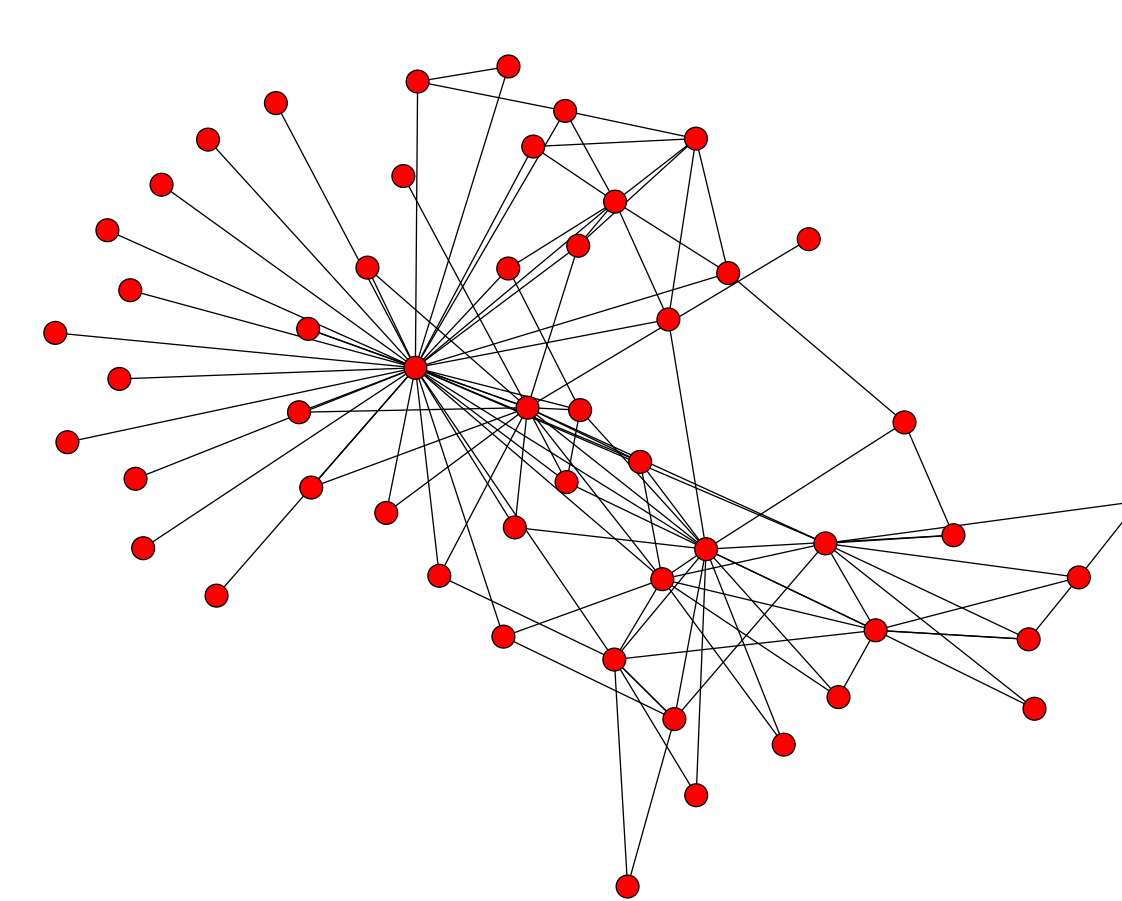
Team Members:
Jamie Fitzgerald
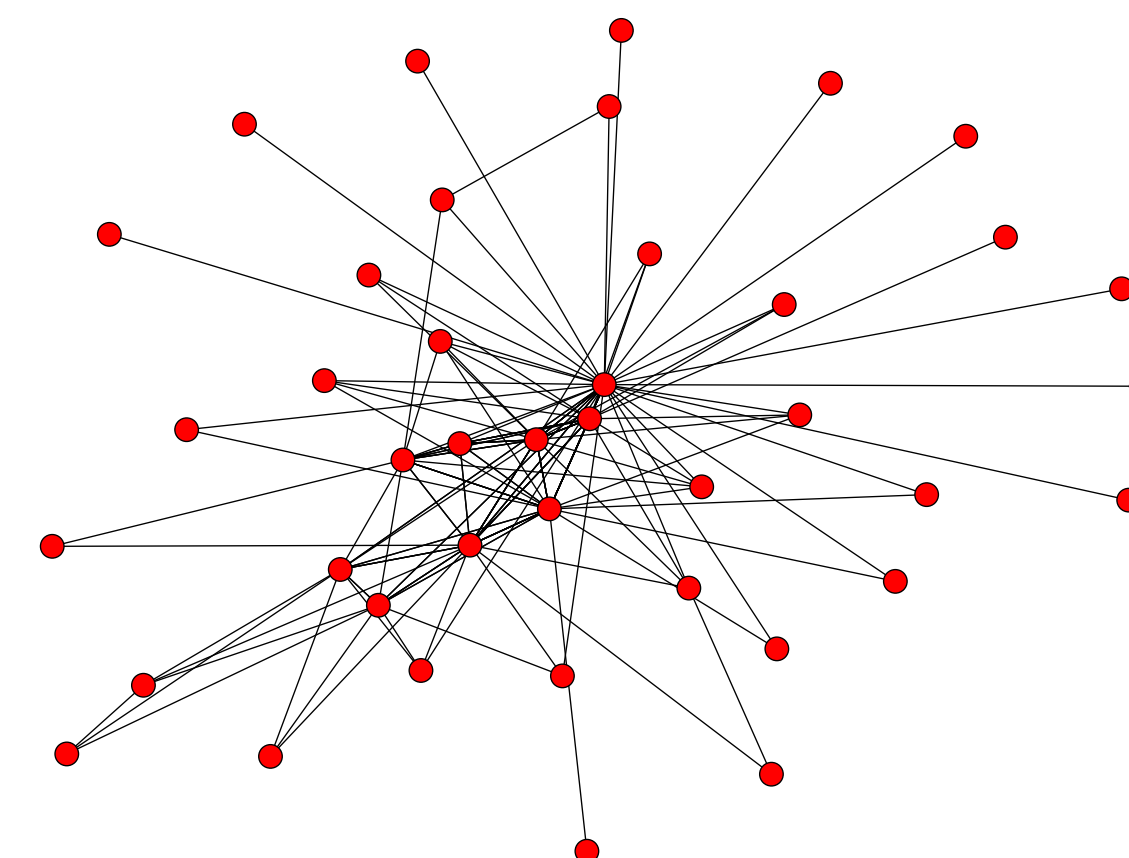Riqu Huang
Roopa Krishnaswamy
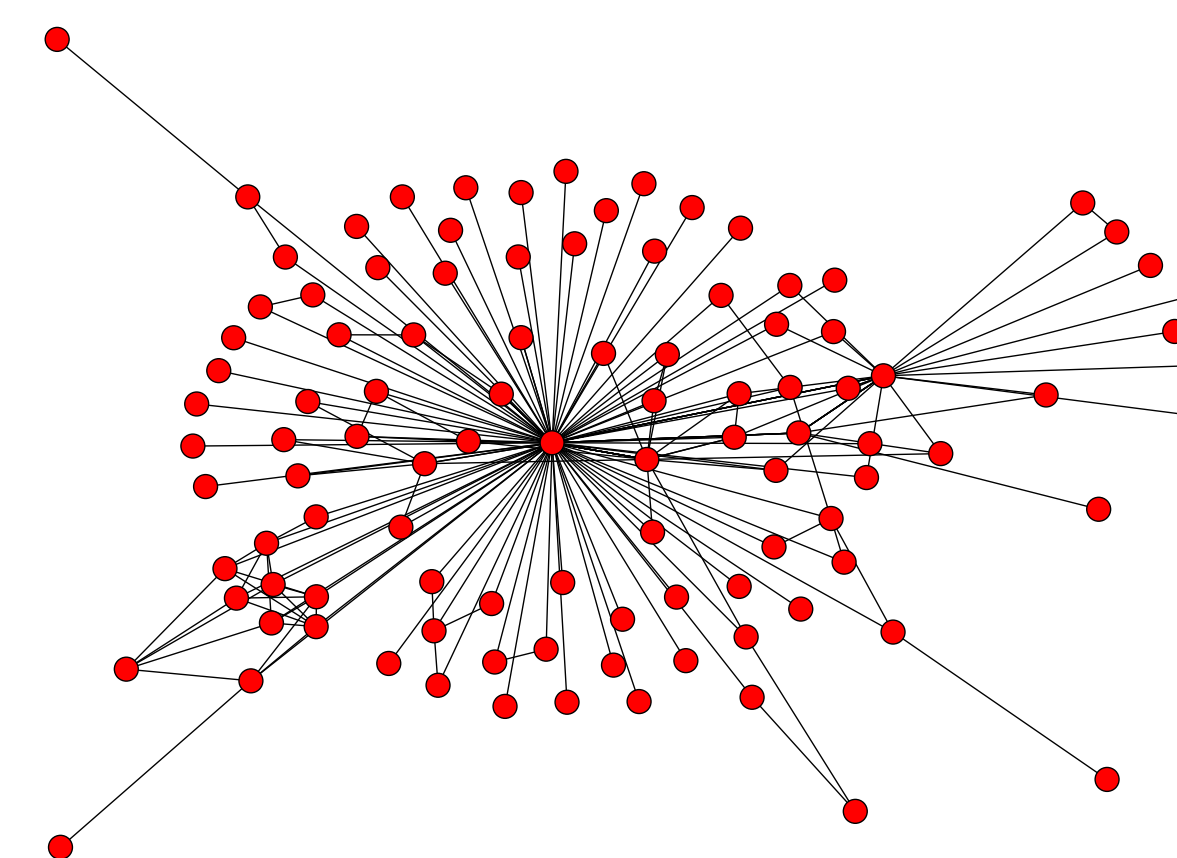Riley Neal
Manuel Villegas

Results

The Tudors

House of Cards

Keeping Up With The Kardashians

Deadbeat

Cops

The network corresponding to each TV show
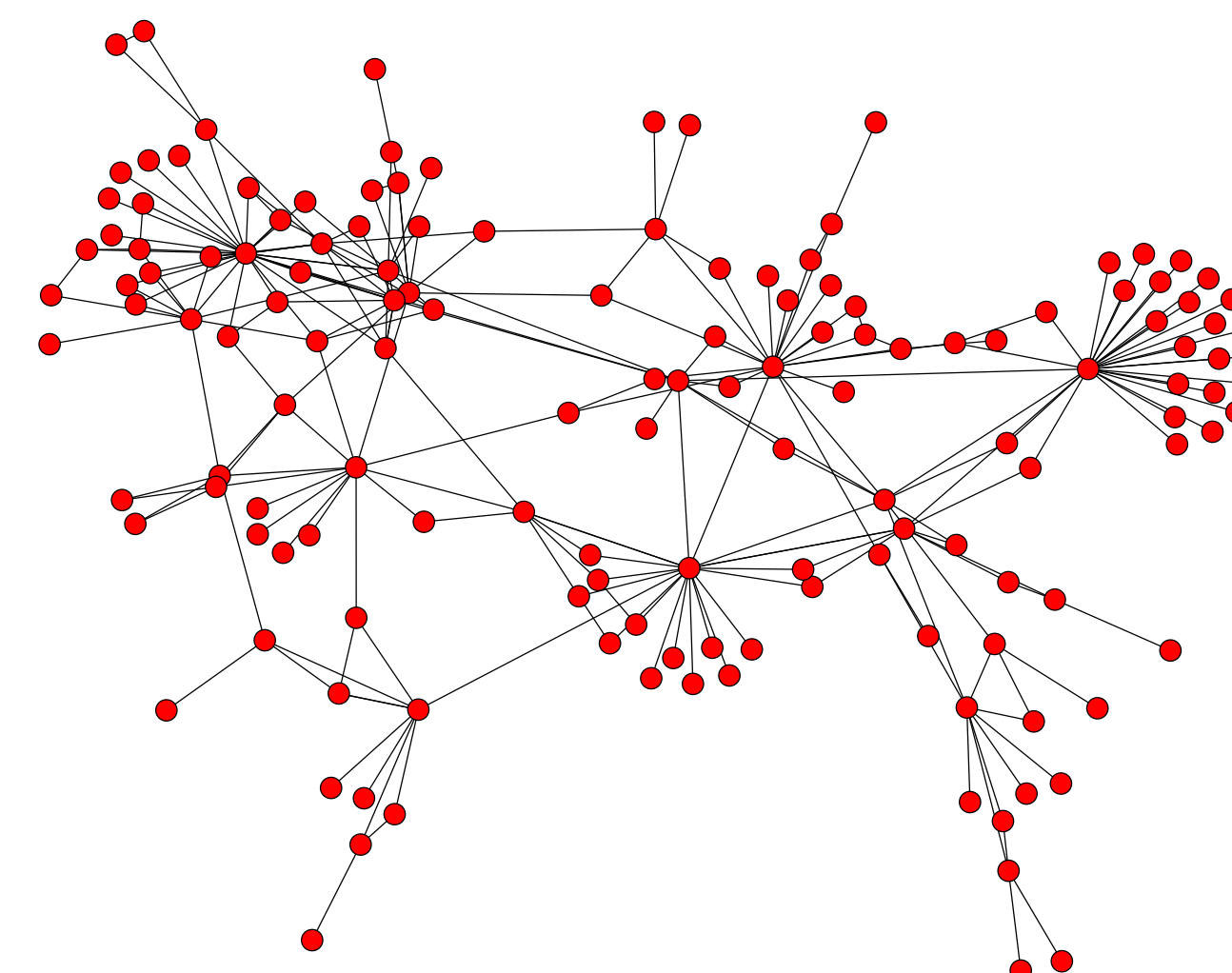
Results

Network	N	$<k>$	l	lrand	lmax	C	Crand	Gc	r
Keeping Up With the Kardashians	41	8.44	2.07	1.91	4	0.59	0.21	1.00	-0.28
The Tudors	57	5.90	2.55	2.45	5	0.32	0.088	1.00	-0.29
House of Cards	52	4.30	2.29	3.21	4	0.49	0.057	1.00	-0.43
Cops	182	3.10	3.92	4.34	8	0.33	0.022	0.80	-0.30
Deadbeat	102	3.33	2.20	3.64	4	0.46	0.014	1.00	-0.41

The size, mean degree, mean path length, diameter, clustering coefficient, giant component, and assortativity for the TV shows, along with the mean path length and clustering coefficient for similarly sized random networks.

	Social	Fiction	Kardashians	The Tudors	House of Cards	Cops	Deadbeat
Small World	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hierarchy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
p(k)	Power Law	Exponential	Power Law	Power Law	Power Law	Power Law	Power Law
Scale Free	Yes	No	No	No	No	No	No
Gc	<90%	>90%	>90%	>90%	>90%	<90%	>90%
TA	Vulnerable	Robust	Robust	Robust	Robust	Robust	Vulnerable
Assortative	Yes	No	No	No	No	No	No

Summary of properties of TV shows compared to social and fictional networks taken from [1].

All five networks possess qualities of both social and fictitious networks. Of the five, Cops was the show that most closely resembled a real social network.

Glossary of Technical Terms
- **Small World** – Most nodes in the network are not directly connected but they can be reached from each other by a small number of steps.
- **Hierarchical Network** – A network that is organized into modular structures.
- **Scale Free** – A network that has the degree distribution $p(k) \sim k^{-\gamma}$ where $2 < \gamma \leq 3$.
- **Degree Distribution** - Probabilistic distribution for the degrees of each node.
- **Clustering Coefficient** – The density of the neighboring connections of a node.
- **Giant Component** – The largest connected component of a network.
- **Assortativity Coefficient:** The Pearson correlation coefficient of degree between pairs of linked nodes.
- **Structural balance** – The propensity to disfavor odd numbers of edges in a closed triad.
- **Betweenness Centrality** – A measure of network connectivity that describes the influence of nodes in terms of flow.
- **Target Attack** – Removing the top characters with the highest degree ranking.

References
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