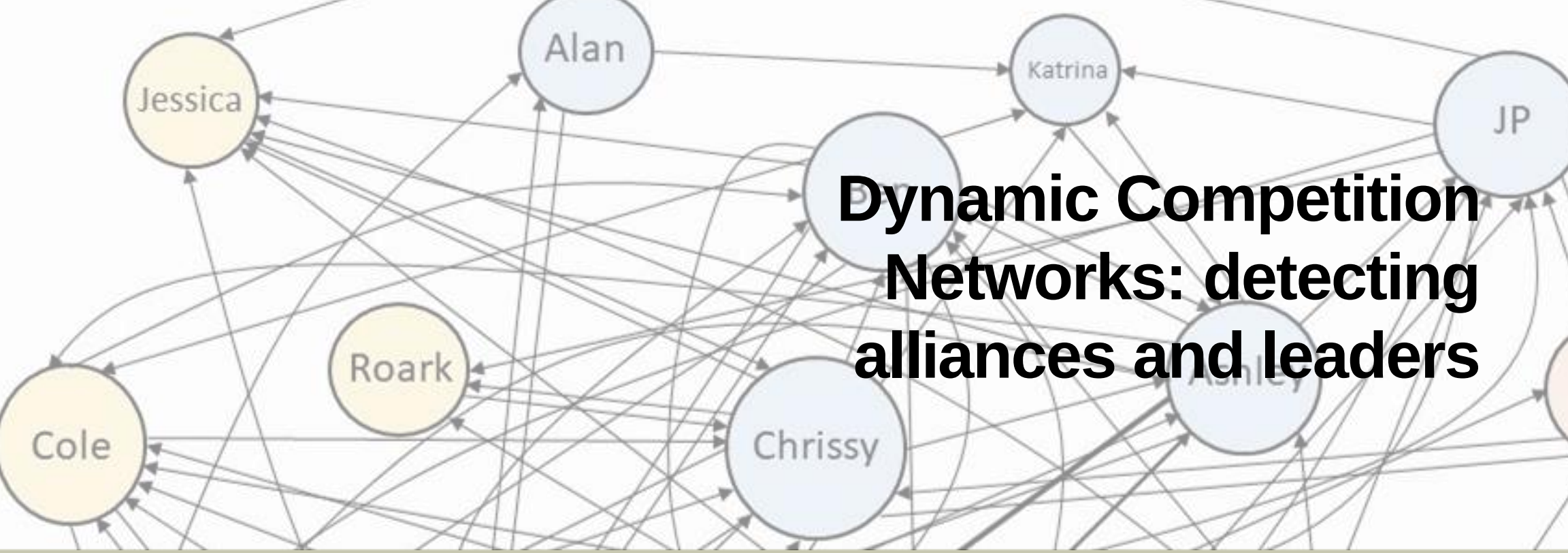

Dynamic Competition Networks: detecting alliances and leaders

Code & Data
http://www.math.ryerson.ca/~abonato/papers/SurvivorBB_Data_BEGM



Anthony Bonato (Ryerson)
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David Gleich (Purdue)

Nicole Eikmeier

Purdue University

In Traditional Networks, edges are "POSITIVE"

Edges are friendship

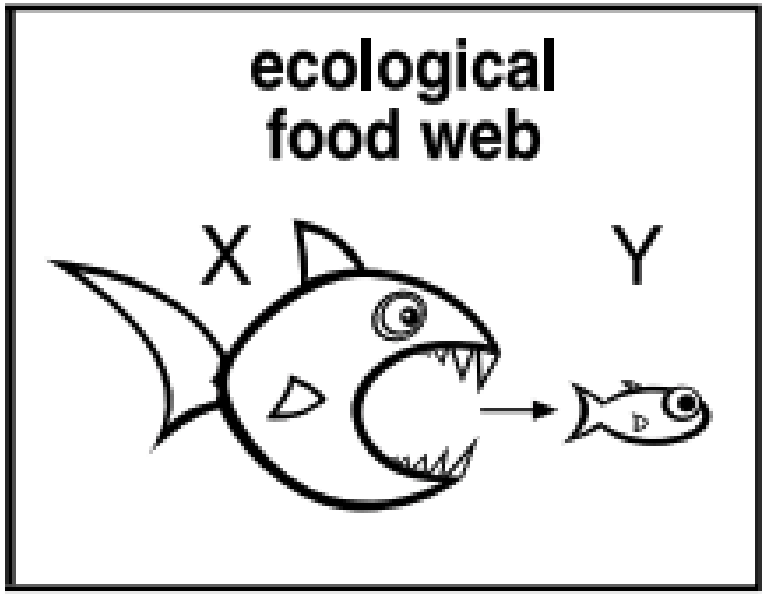
Edges are professional connections

Edges are subscribers

What about “NEGATIVE” interactions?

Examples:

Geo-political Networks
Competitive Social Games
Food Webs
Signed Networks (the negative portion)



Milo et. Al, Science, 2002

Motivating Questions in Negative Interactions

Can we predict winners in the case of a competitive situation?

How do negative interactions drive link formation?

Structural Balance Theory

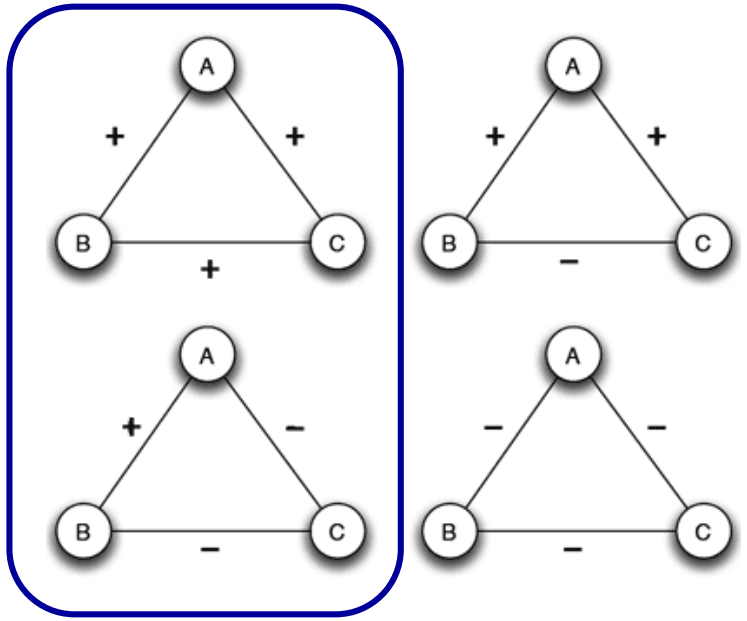
Heider, 1958

Easley, Kleinberg, 2010

Considers triads of nodes

Triads seek *closure*

balanced



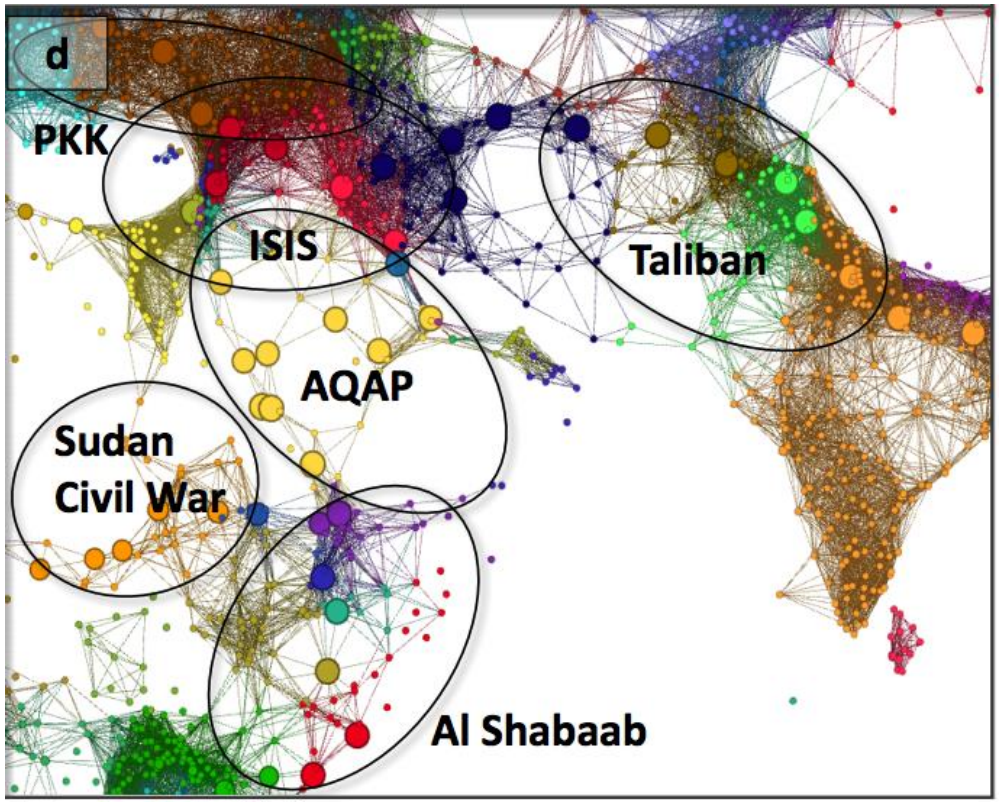
unbalanced

Related Work – Negative Interactions

Guo et. al, Preprint, 2018

Form a network based on spatial location of cities and predict the rise of conflict and violence

Their analysis is based on degree and betweenness



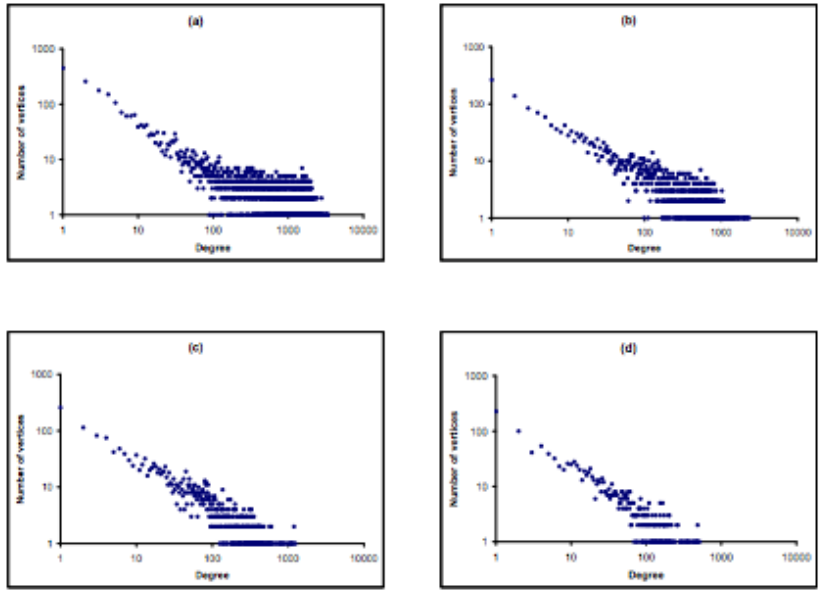
Related Work – Negative Interactions

Boginski, Butenko, Pardalos, 2003

Study negative interactions between stocks on the stock market

Analysis on the graph:

- Power-law distribution in the degrees
- Find independent sets, sets of stocks whose prices change similarly over time



Dynamic Competition Networks

Nodes: people/organizations

Edges: directed edge (u,v) exists if v is a competitor of u

Edges are added over time

Social Game Shows

Nodes: players

Edges: (u,v) exists if player u votes against player v

There can be multiple edges between two nodes

Network Metrics

In-Degree: The number of edges coming into a node

Common out-neighbor (**CON**) scores count the total number of times a node has a similar out-neighbor as other nodes

$$CON(u,v) = |\{z : z \text{ is a common out neighbor of } u, v\}|$$

$$CON(u) = \sum_{v \in V(G)} CON(u,v)$$

The **closeness** of a node is $\left(\sum_y d(x,y)\right)^{-1}$

A set of nodes is **near-independent** if its edge density is small

$$ED(S) = \frac{|E(S)|}{\binom{|S|}{2}}$$

alliances:

clusters of nodes who pool influence to achieve objectives

leaders:

high standing in the network

edges from leaders may influence edge creation among other nodes

Dynamic Competition Hypothesis (DCH)

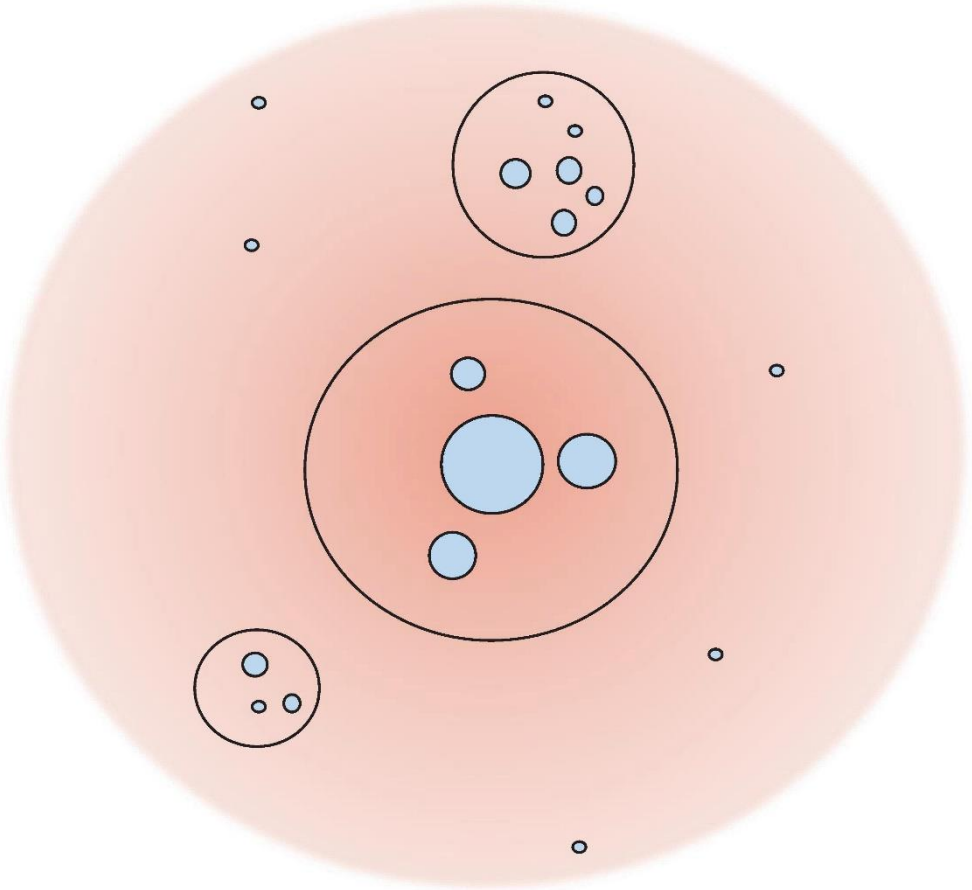
Bonato, Eikmeier, Gleich, Malik, 2018

Dynamic Competition Networks satisfy the following rules:

- Alliances are near independent sets
- Strong alliances have low edge density
- Members of an alliance with high CON score are more likely leaders
- Leaders exhibit high closeness, high CON scores, and low in-degree

While we expect leaders to be in an alliance, leaders are determined via global metrics

DCH Visualized



Social Game Shows

Survivor

- 35 US seasons

http://survivor.wikia.com/wiki/Main_Page

Big Brother

- 20 US seasons

http://bigbrother.wikia.com/wiki/Big_Brother_Wiki

Survivor: Game Changers

DCH:

- Alliances are near independent sets
- Strong alliances have low edge density
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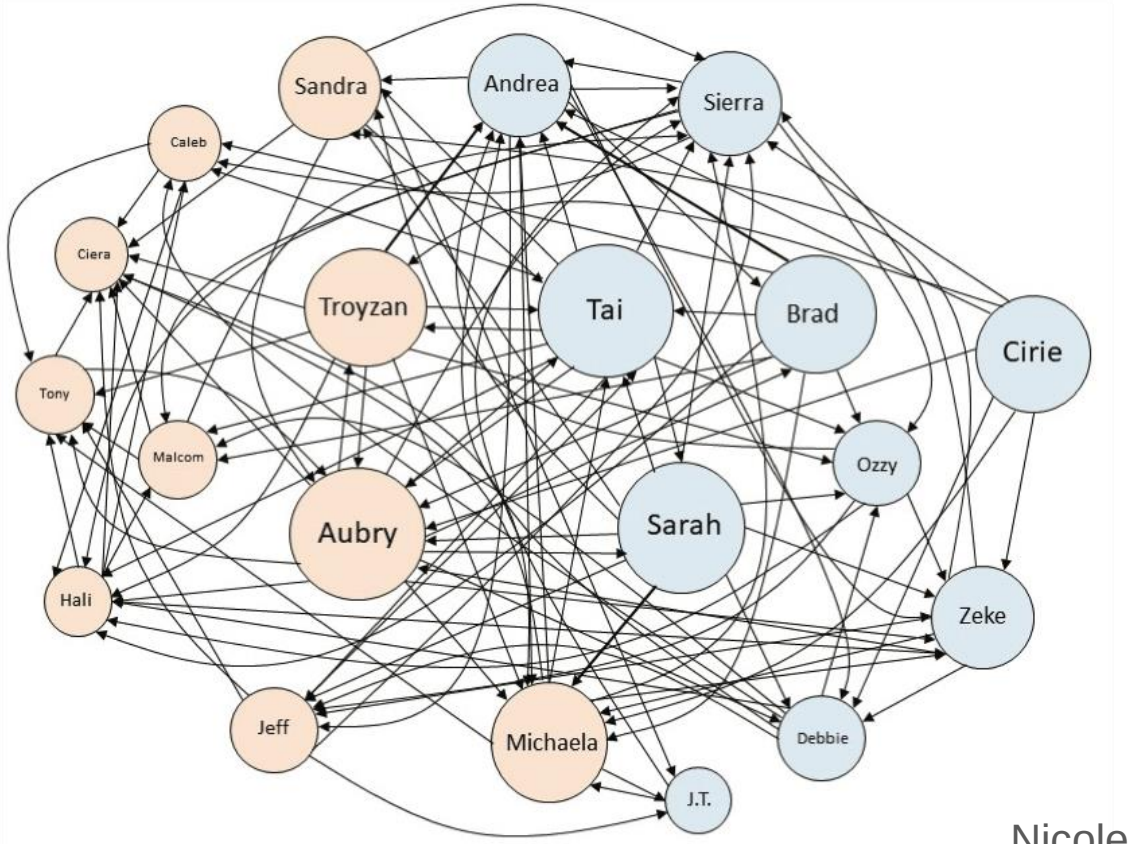

Game Changers				
Name	ID	OD	C	CON
Sarah	3	13	0.692	64
Brad	2	12	0.643	49
Troyzan	2	12	0.643	55
Tai	12	13	0.72	56
Aubry	9	13	0.72	61
Cirie	0	8	0.613	45
Michaela	11	11	0.643	51
Andrea	14	8	0.581	39
Sierra	15	7	0.581	34
Zeke	11	6	0.6	39
Debbie	6	7	0.545	32
Ozzy	7	4	0.5	22
Hali	8	5	0.474	28
Jeff	6	5	0.529	33
Sandra	5	5	0.581	34
J.T.	3	2	0.45	18
Malcolm	5	3	0.439	24
Caleb	5	3	0.4	21
Tony	7	2	0.439	15
Ciera	9	1	0.4	8

Survivor: Game Changers

Edge Density: 0.233

DCH:

Alliances are near independent sets
Strong alliances have low edge density
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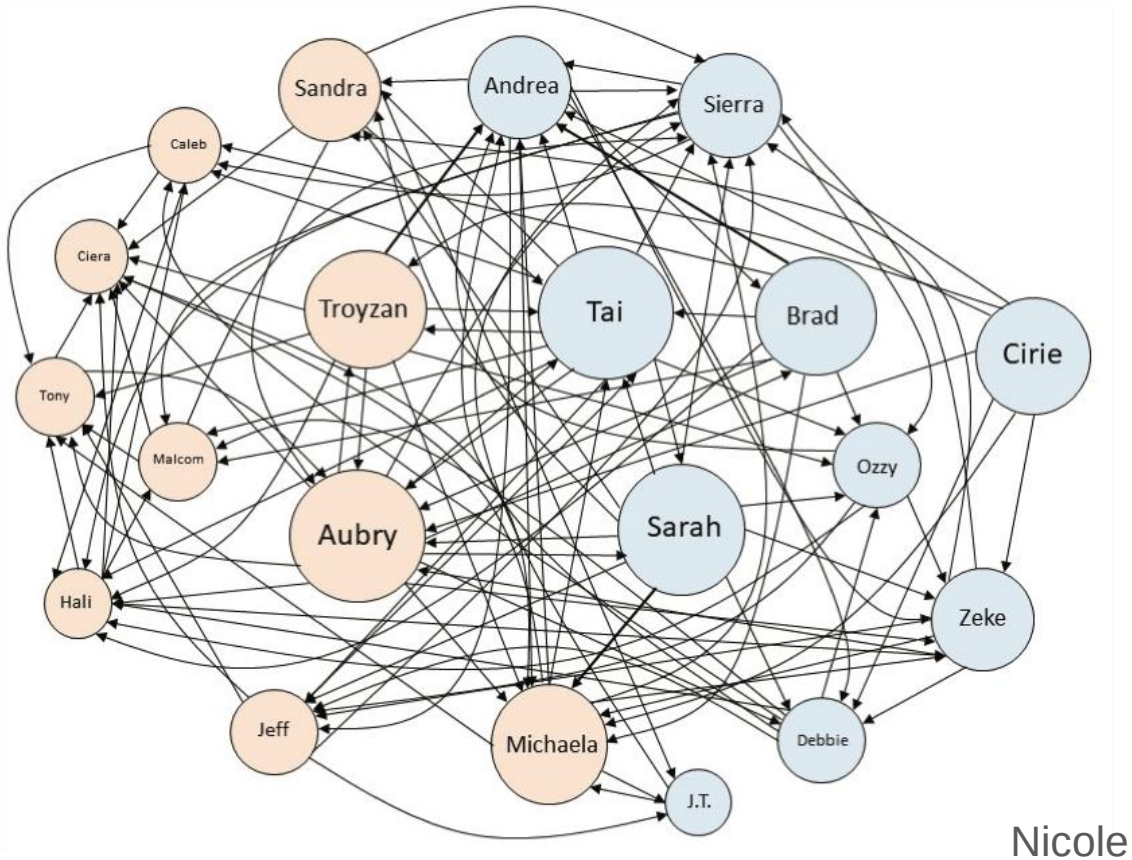

Game Changers				
Name	ID	OD	C	CON
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Survivor: Game Changers

Edge Density: 0.266

DCH:

Alliances are near independent sets
Strong alliances have low edge density
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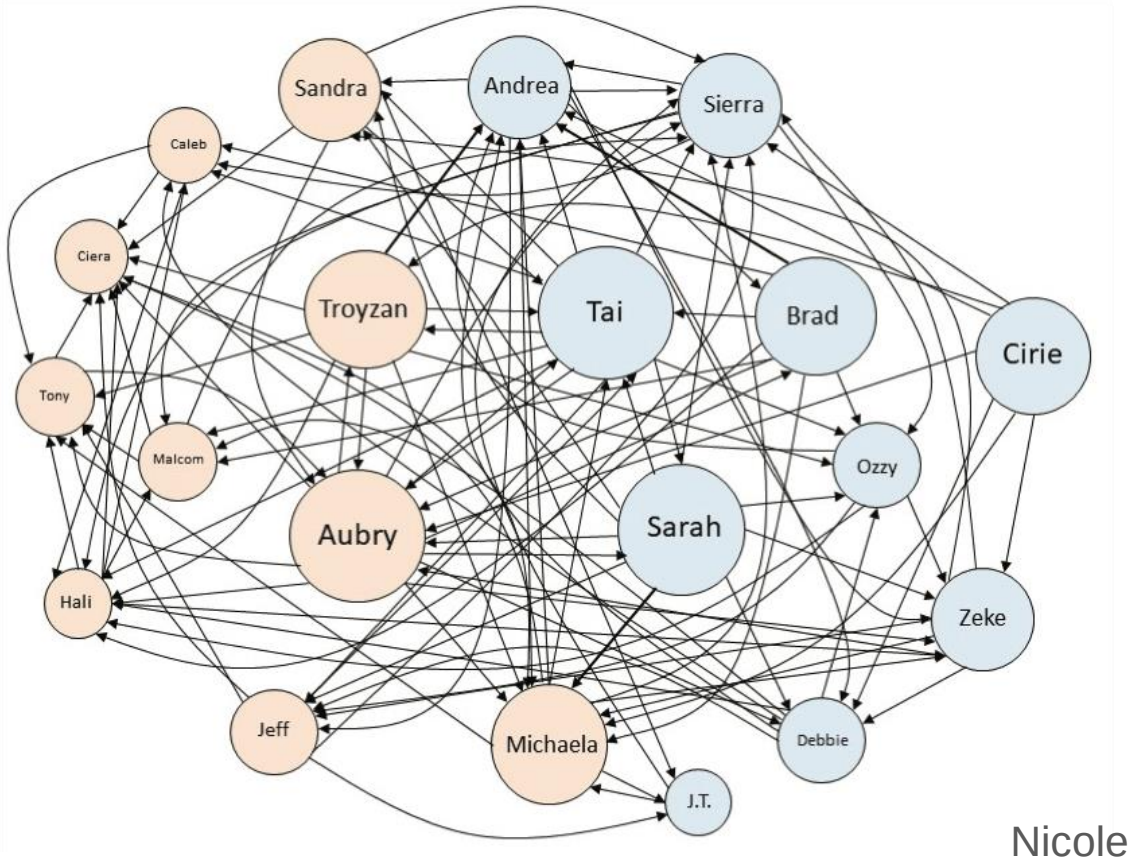

Game Changers				
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CON is a good choice of metric

DCH:

- Alliances are near independent sets
- Strong alliances have low edge density
- Members of an alliance with high CON score are more likely leaders
- Leaders exhibit high closeness, high CON scores, and low in-degree

		CON
Survivor	Top 3	68.6
	Top 5	94.3
Big Brother	Top 3	60.0
	Top 5	70.0

★ **there are only 20 seasons of Big Brother, with sometimes as few as 10 players**

Edge Density of Alliances

DCH:

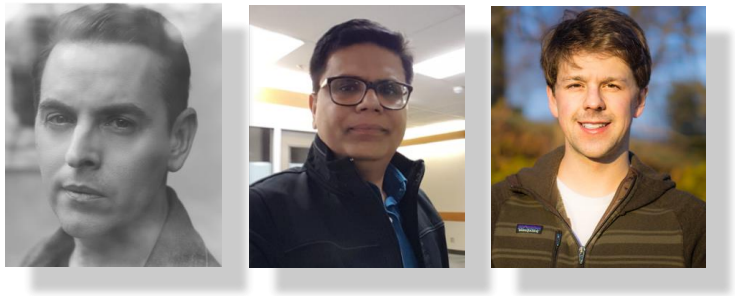
- Alliances are near independent sets
- Strong alliances have low edge density
- Members of an alliance with high CON score are more likely leaders
- Leaders exhibit high closeness, high CON scores, and low in-degree

To what extent do alliances have a smaller edge density than the edge density of the entire graph?

- 60% of Survivor seasons
- 95% of Big Brother Seasons

Alliances are complicated to analyze

Thank you!



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Code & Data
http://www.math.ryerson.ca/~abonato/papers/SurvivorBB_Data_BEGM

Contributions

- Notion of a Dynamic Competition Network
- Dynamic Competition Hypothesis:
  - detects leaders
  - measures strength of alliances
- Test of DCH on social game shows Survivor and Big Brother

Questions & Future Work

- Does the DCH apply to other types of networks?
- Can we invert the DCH to determine low-ranked members?
- Apply the DCH to international seasons of Survivor and Big Brother
- Analyze Social Network Games at earlier stages in formation of the network