# 15-396

## Science of teh Interwebs

# What's on the Final?

Overview

Networks I: Centrality + Prestige

Networks II: Structural Balance

Networks III: Innovation Diffusion

Identity and Privacy I

Identity and Privacy II

Revolts and Thresholds

Preliminaries of Game Theory

Auctions Network Traffic

Sponsored Search

Web Search I

Web Search II

Recommendation Systems

Voting

Wikipedia Melee

Watermarking, DRM

CAPTCHAs

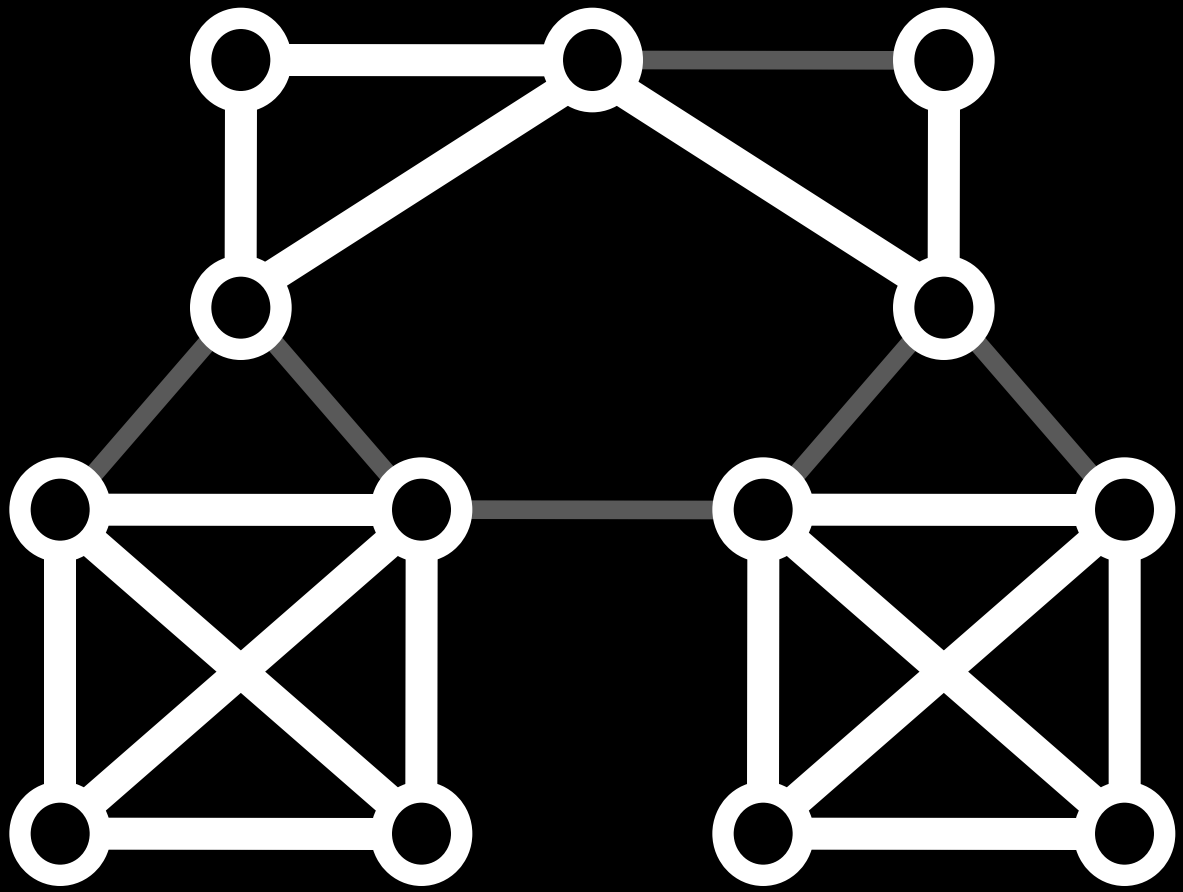
Content Aggregation

Natural Language Processing

You wanna start a company?

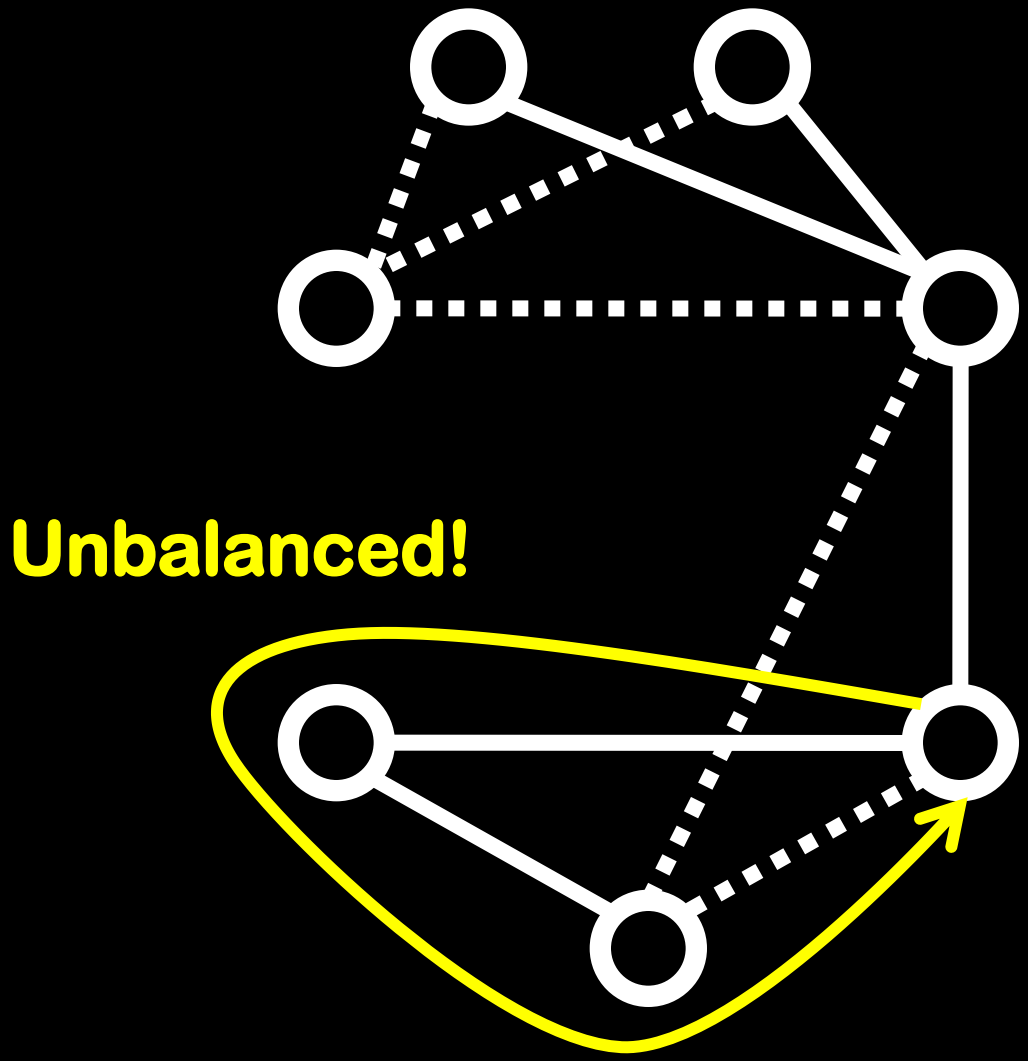
**You can vote one lecture off!**

# Social Network Theory



**Does this network satisfy the strong triadic closure?**

# Is this Graph Balanced?



**Definition:** A cycle is balanced if the product of its signs is positive

**Definition:** A graph is balanced if all its cycles are balanced

# Clusters Stop Cascades

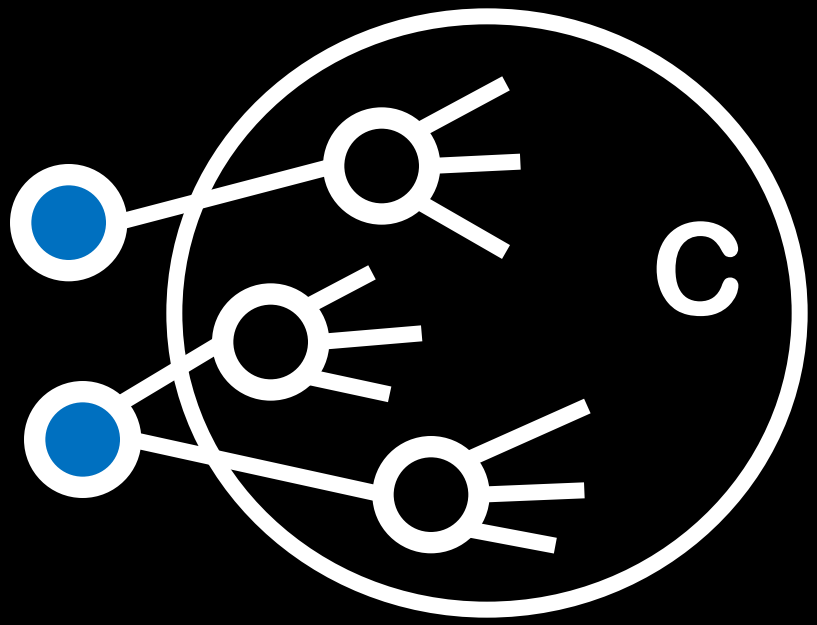
**Theorem:** Let S be an initial set of adopters of A. Assume the nodes all apply a threshold q to decide whether to switch to A.

If G-S contains a cluster of density greater than (1-q), then S cannot cause a cascade

**Proof (by contradiction):**

Let t be the first time that a node in C adopts A

But, by time t-1 some other node in C must have adopted A

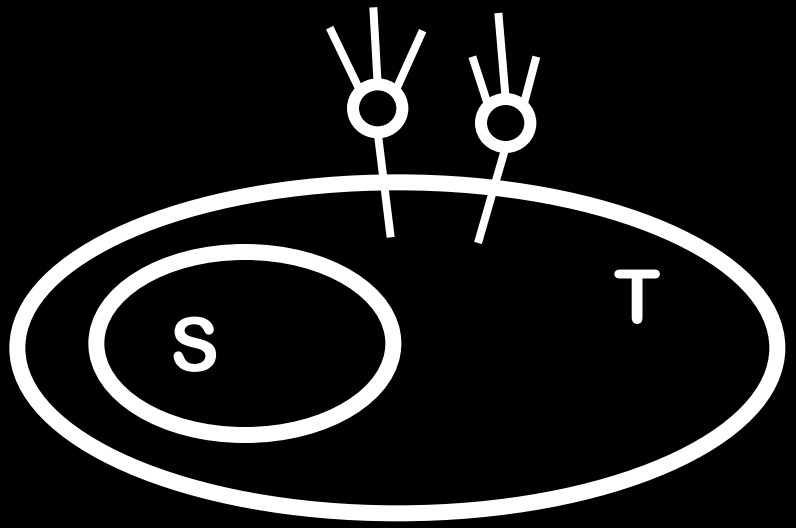


# Only Clusters Stop Cascades

**Theorem:** If a set S of initial adopters fails to cascade with a threshold q, then there is a cluster in G-S of density greater than (1-q).

**Proof:**

T = set of nodes that eventually adopt A




If $v \in$ G-T, less than a q fraction of its neighbors are in T

Which means that more than a (1-q) fraction of its neighbors are in G-T

# Game Theory


(L,H) will be played

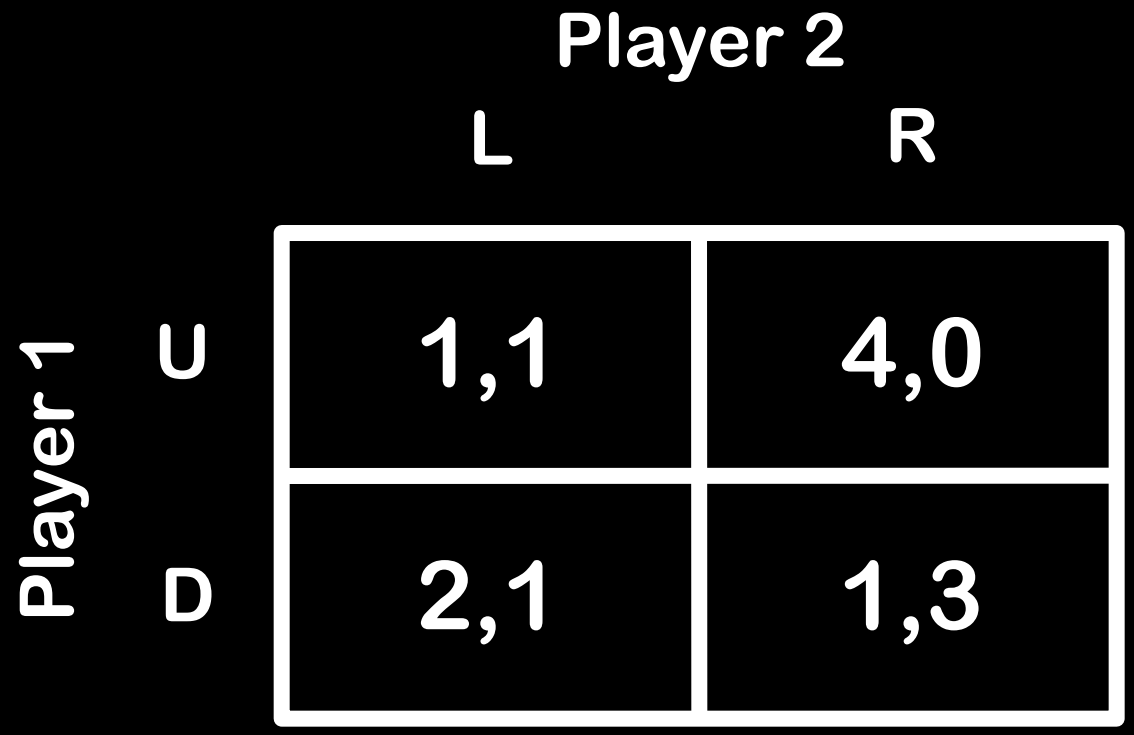
| | | Player 2 | | |
|---|---|---|---|---|
| | | L | M | R |
| Player 1 | t | 3,3 | 2,2 | 2,1 |
| | m | 2,2 | 1,2 | 3,1 |
| | b | 1,2 | 3,1 | 2,3 |

# Neither player has a dominant strategy

# Nash Equilibrium

A pair of strategies $(s_1^*, s_2^*)$ is in Nash Equilibrium if $s_1^*$ is a Best Response by player 1 to $s_2^*$, and $s_2^*$ is a Best Response by player 2 to $s_1^*$.

| Player 1 \ Player 2 | L | M | R |
|---|---|---|---|
| t | 3,3 | 2,2 | 2,1 |
| m | 2,2 | 1,2 | 3,1 |
| b | 1,2 | 3,1 | 2,3 |




**(p=2/3,q=3/4) is an equilibrium!**

**Player 1 is only willing to randomize if the expected payoffs of U and D are equal:**

$$q+4(1-q)=2q+(1-q), \text{ so } q=3/4$$

# Bidding your true value is a dominant strategy in a second price sealed bid auction

$v_i$ = bidder i's value for the object

$b_i$ = bidder i's bid for the object

A bidder's **strategies** are bids as functions of their values

The payoff to bidder i with value $v_i$ and bid $b_i$ is:

$$\begin{cases} v_i - \max_{j \neq i} b_j & \text{if } b_i > \max_{j \neq i} b_j \\ 0 & \text{otherwise} \end{cases}$$

$v_i$ = bidder i's value for the object

$b_i$ = bidder i's bid for the object

$$\text{Payoff} = \begin{cases} v_i - \max_{j \neq i} b_j & \text{if } b_i > \max_{j \neq i} b_j \\ 0 & \text{otherwise} \end{cases}$$

**Theorem:** Bidding $b_i = v_i$ is a dominant strategy

If $b_i > v_i$ bidder i could get object and pay more than what she values it for (and thus go negative)

If $b_i < v_i$ bidder i could fail to obtain the object; obtaining the object can get her positive payoff

How does Google Ads Work?

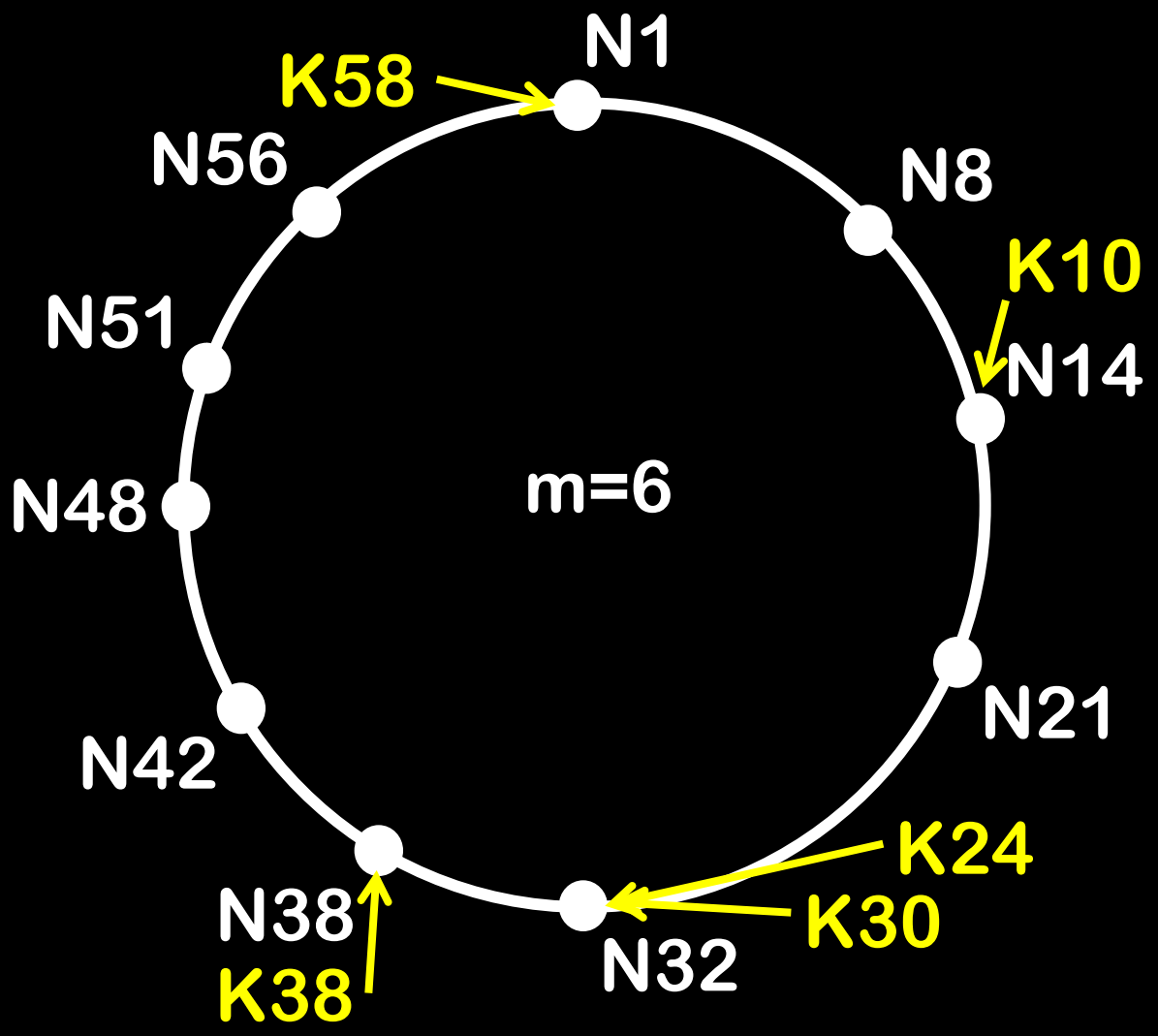
How is it different from VCG?

# How Does PageRank Work?

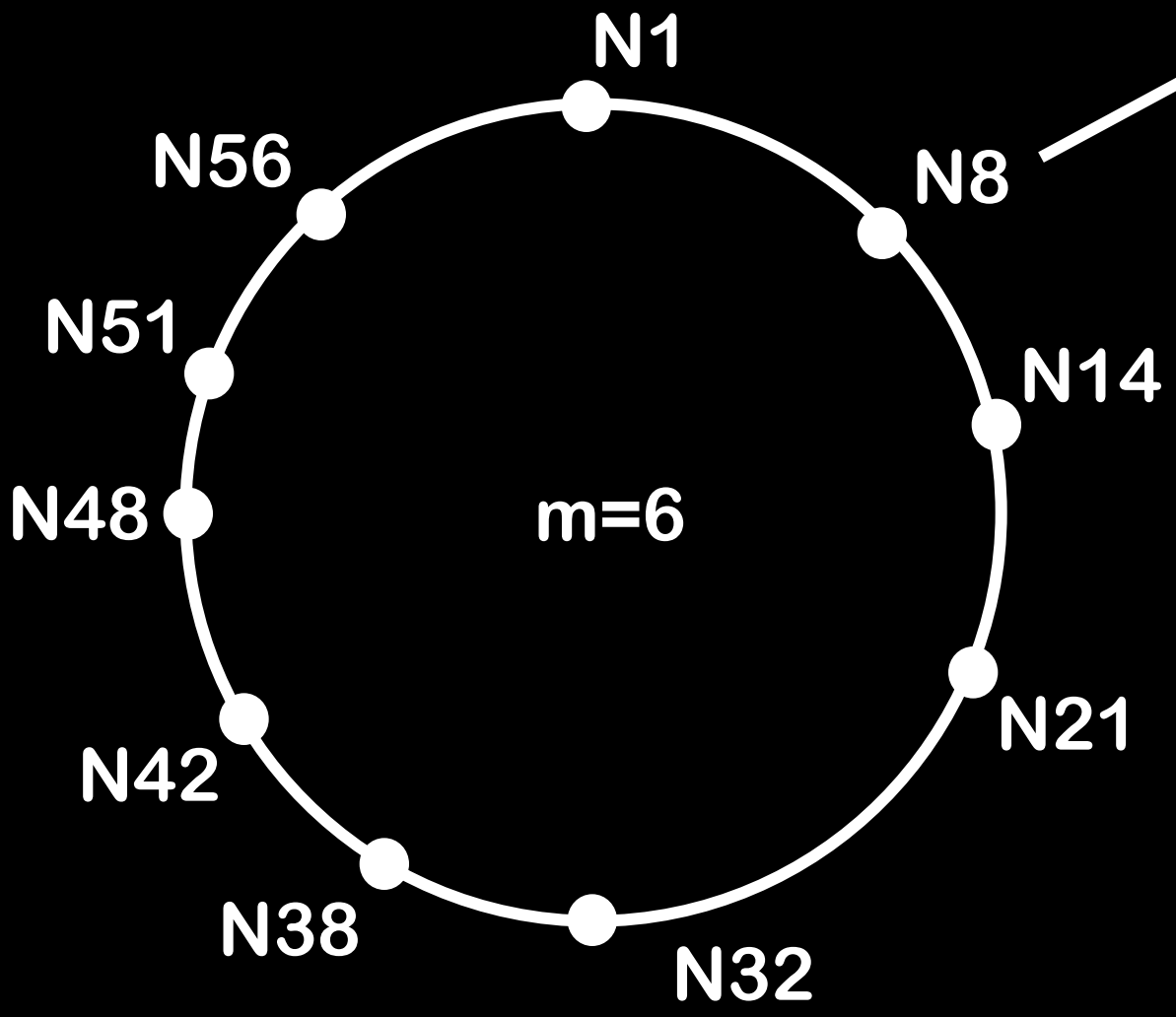
# The Chord Ring

A ring with positions numbered 0 to $2^m-1$

Key k is assigned to node successor(k) = node whose identifier is equal to or follows the identifier of k



The $i^{th}$ entry of node n will contain the address of successor($n+2^i$)




N8+1 = N14
N8+2 = N14
N8+4 = N14
N8+8 = N21
N8+16 = N32
N8+32 = N42

# What I Wanted From the Class

Not too much work for you

A blend of theory and practice

Get you to experiment with real life systems

# Lord of the Flies

I learned that even reasonable people can easily become spammers!

Assignments from this class made it to Slashdot, Digg, Reddit

g2g

ttyl