

BRANDED WITH A SCARLET “C”: CHEATERS IN A GAMING SOCIAL NETWORK

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Video games are a huge industry

- Modern Warfare 2 released Nov. 2009
 - First 24 hours of release
 - 4.7 million units sold
 - \$310 million in revenue
 - First 5 days of release
 - 8 million online players
- All these numbers eclipsed by MW3 in 2011!



Multiplayer gaming: growing eSports industry

Major League Gaming claims
225% growth from 2010 to 2011

Team Na'Vi won \$1 million
in the DOTA Intl.
Tournament

"Flash" makes
\$250k a year
playing StarCraft!



But not all is well...

- Fame and fortune attracts deviant behavior
- Virtual goods worth \$ attract criminal element
- Competitive gameplay attracts cheaters
 - Multiplayer games are a distributed system
 - Some computation left to gamers' machines
 - Susceptible to attacks
- \$100k a year to cheat creators for single game

Real world cheat: Wallhack



What can we learn from a gaming community?

- Social systems have unethical actors
- Cheating in games is black and white
- Theories indicate unethical behavior has a social component

What are the network characteristics of unethical actors in a large scale online community?

Steam Community

- Large online social network for PC gamers
- Built on top of Steam digital delivery platform
- Purchased games permanently tied to account
- Steam account required to create Steam Community profile
 - Steam Community profile not required to play games

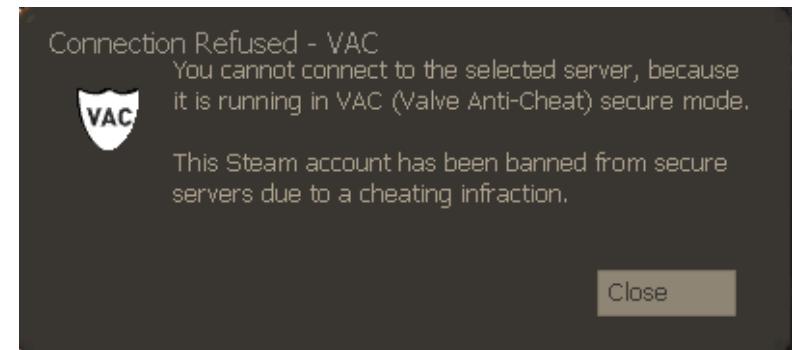
Steam Community Profile

- Unique SteamID
 - Friends list
 - User specified location
 - Cheating flag (VAC ban)
 - Nickname (mutable)
 - Date of account creation
 - Screenshots
 - Videos
 - Comments (“wall posts”)
 - Profile information
 - Game reviews
 - Counter-Strike: Global Offensive (1st, Ministry of Defence)
 - Team Fortress 2 (1st, Valve)
 - Half-Life 2 (1st, Valve)
 - Clans of Norrath (1st, EA)
 - Esportshead - Alayward Edition (1st, PDRack)
 - Counter-Strike: Condition Zero (1st, DSRock)
 - ESEA (1st, ESEA)
 - DOTA 2 (1st, Valve)
 - CS:GO (1st, Valve)
 - Casville 2000DKR CUP (1st, ANEXIS)
 - Casville 1000DKR CUP (1st, ANEXIS)
 - CPL Major (1st, Valve)
 - Gameplay ownership/stats
 - Virtual goods inventory

Currently Online	
<hr/>	
Actions	
 Add to your friends list	
 View Inventory	
<hr/>	
Gameplay Stats	
Member since:	October 31, 2003
Steam Rating:	1.5
Playing time:	4.8 hrs past 2 weeks
VAC status:	ban(s) on record ?
	Counter-Strike: Source 4.8 hrs / 207.7 hrs View stats
View all 25 games	
<hr/>	
Friends	
	aim in-Game Counter-Strike: Source - Join
	HelsinGOD @ New PC in-Game Counter-Strike: Source - Join
	MENIX in-Game Counter-Strike: Source
	pto-gaming.org Krl;hex2 in-Game Counter-Strike: Source - Join
	Street in-Game Football Manager 2011
	[R]Nordy www.reason-gaming.net Online Friends since March 20, 2010
View all 395 friends	

The cheating flag

- Cheating automatically detected via Valve Anti Cheat system
 - Method and timestamp not public
 - Delayed application
- Permanent
- Publicly viewable
 - Even private accounts
- Can't play on VAC secured servers
 - Only applies to the game that was cheated in
- Most servers are VAC secured
 - 4,200 of 4,234 Team Fortress 2 servers
- Cheater not permanently removed from Steam Community



Steam Community data set

Type	Nodes	Edges	Profiles	Public	Private	Friends-only	Location set
All users	12,479,765	88,557,725	10,191,296	9,025,656	313,710	851,930	4,681,829
Cheaters	-	-	720,469	628,025	46,270	46,714	312,354

- Data collected March 16 – April 3, 2011
 - Distributed BFS using Amazon EC2
- Cheaters make up 7% of profiles
- 7% of cheaters have private profiles
 - 3% of non-cheaters with private profiles
- Cheaters as likely to be friends-only as private
 - Non-cheaters about 3 times as likely to be friends-only as private

Cheaters more likely to be private than non-cheaters

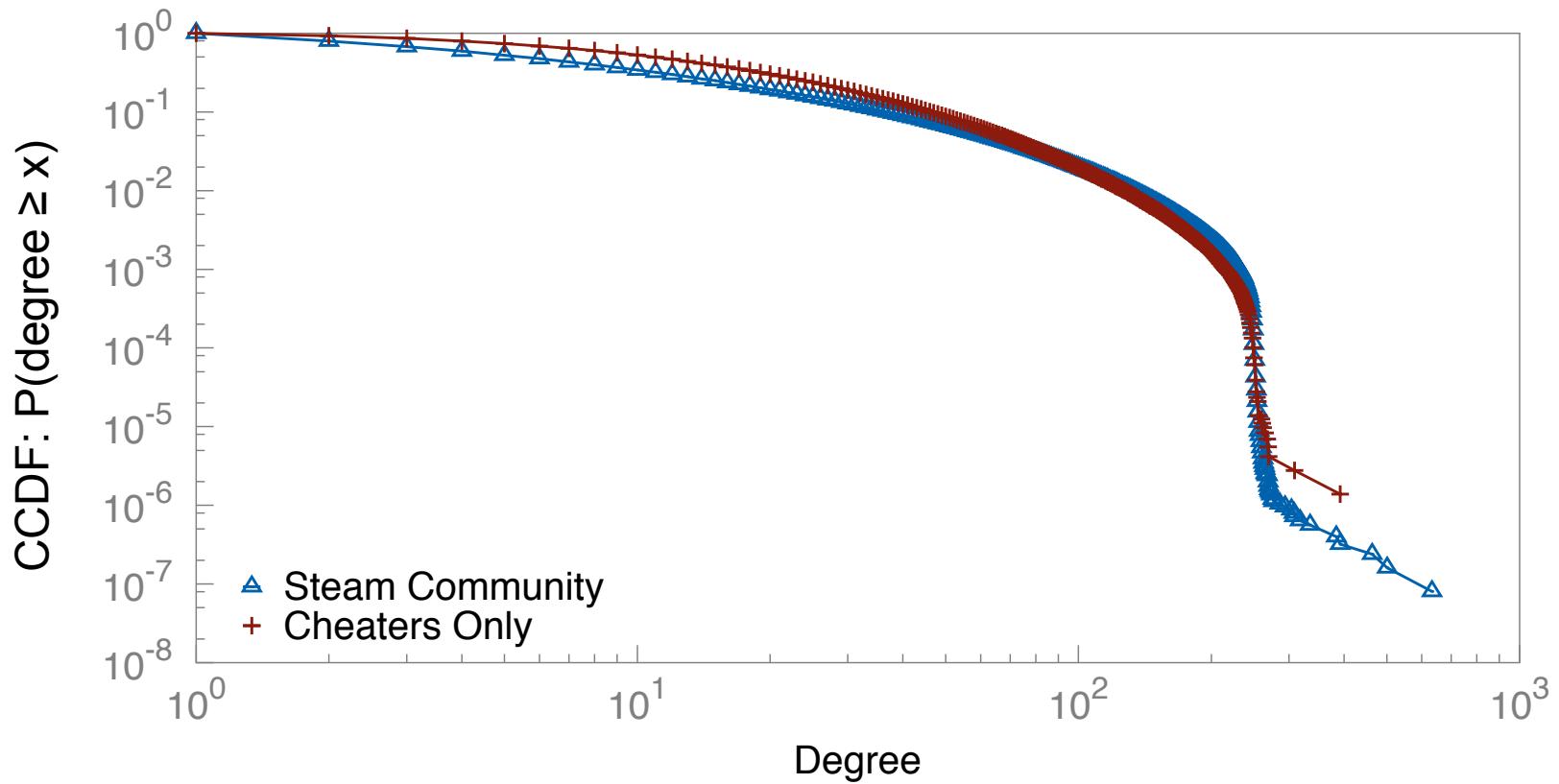
Observing the gaming community

- How are cheaters positioned?
 - In the social community
 - Geographically
- What is the reaction to the cheating brand?
 - From cheaters themselves
 - In the social network
 - In game
- Does the social structure influence cheating?

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Cheaters are well embedded...

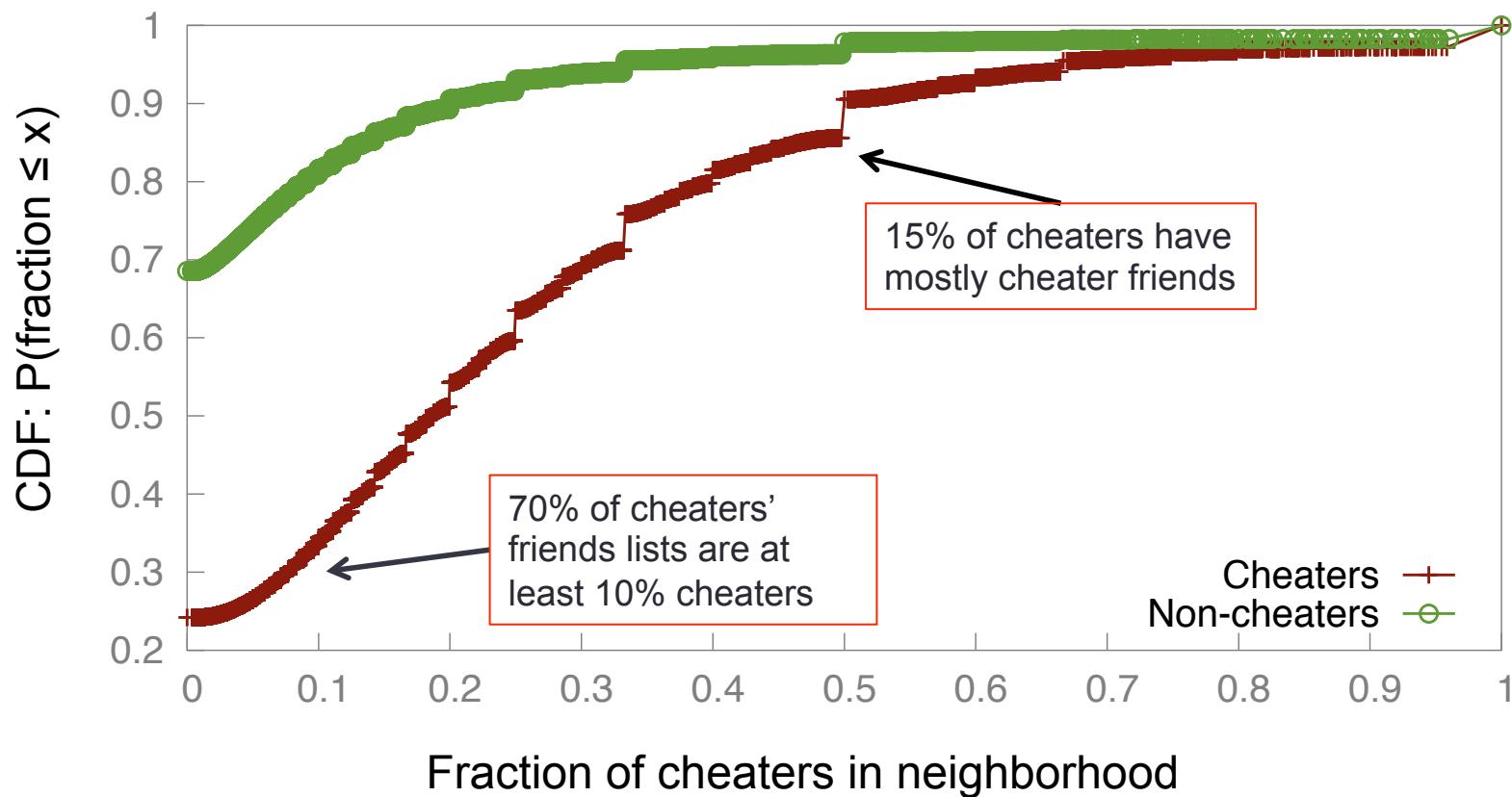


...but are not central

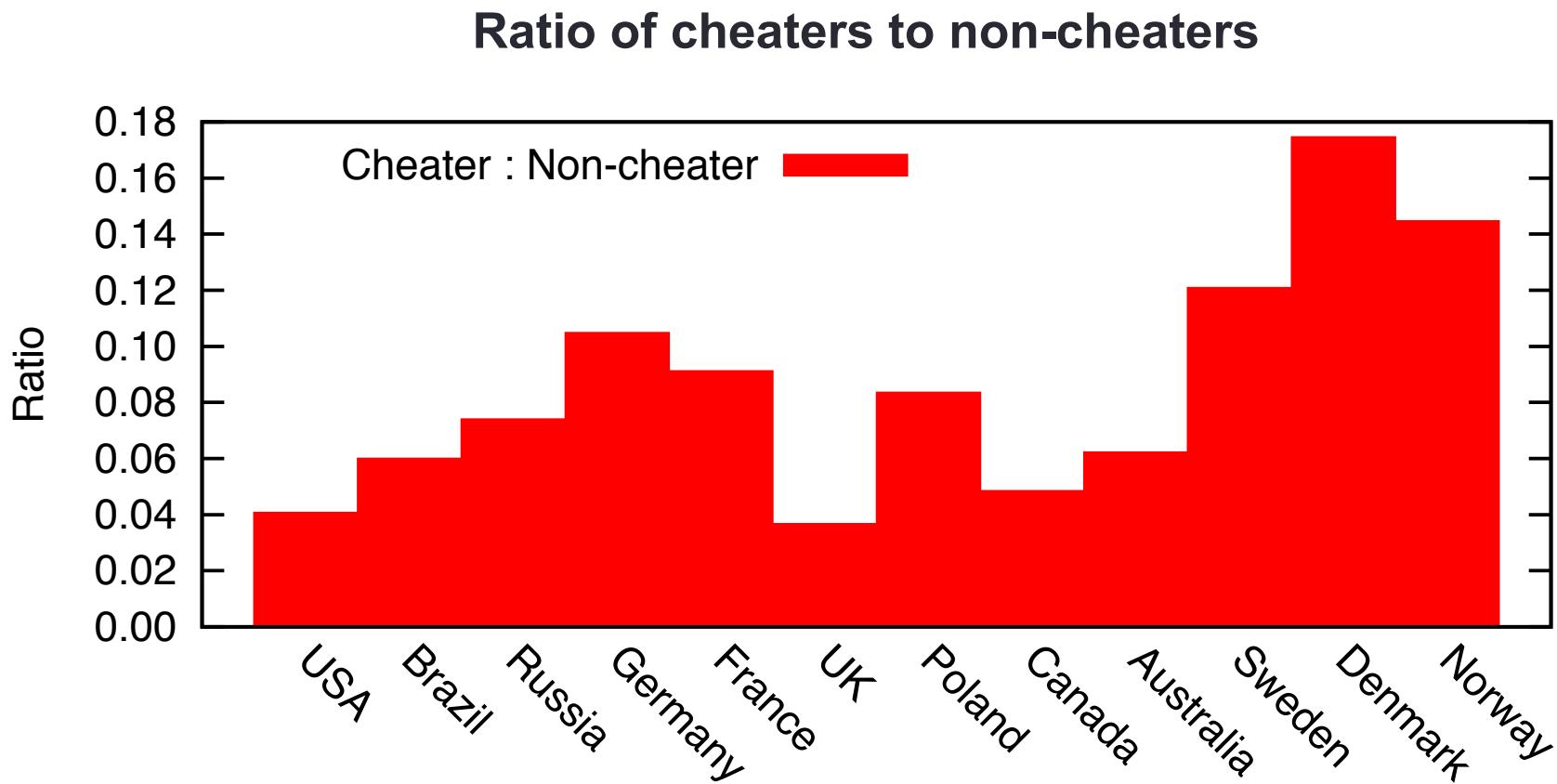
Top-N%	0.1	0.5	1.0	5.0	10.0
Degree	3.25	4.46	5.11	7.06	8.20
Betweenness	5.16	5.95	6.35	7.86	8.58

- Cheaters under-represented among most central players
 - Cheaters make up 7% of player population, but far less than 7% of the top 0.1% central users
 - Not adequately represented until top 5% central users

Cheaters have more cheater friends

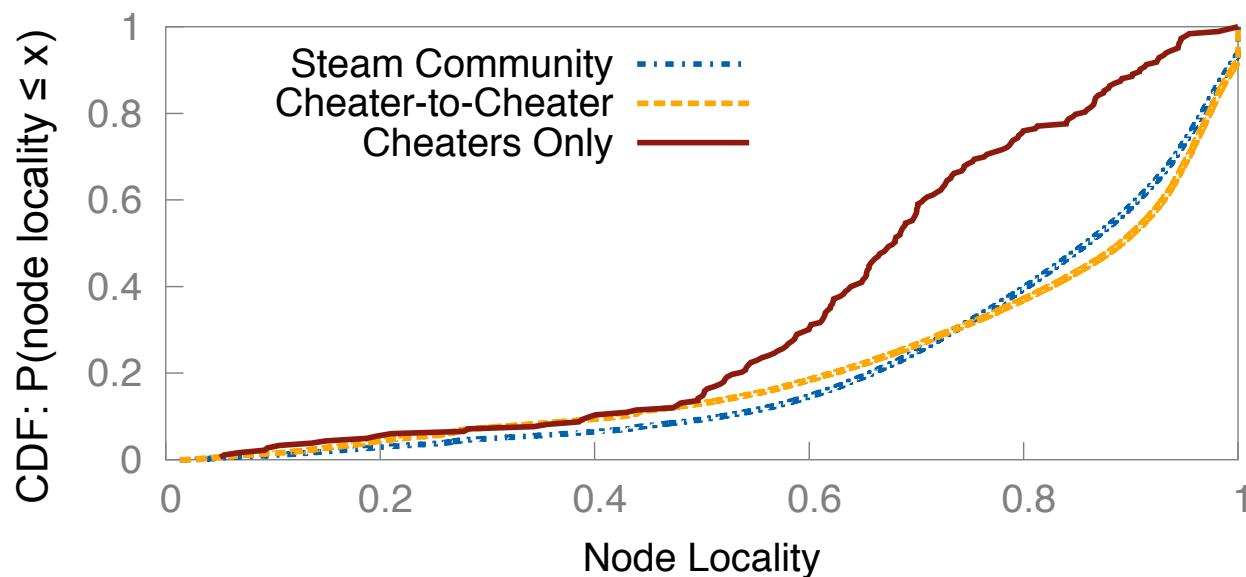


Non-uniform geo-political distribution



Cheaters are geographically closer

Network	# of nodes	# of edges	$\langle D_{uv} \rangle$ (km)	$\langle I_{uv} \rangle$ (km)	$\langle NL \rangle$
Steam Community	4,342,670	26,475,896	5,896	1,853	0.79
Cheater-to-Cheater	190,041	353,331	4,607	1,761	0.79
BrightKite	54,190	213,668	5,683	2,041	0.82
FourSquare	58,424	351,216	4,312	1,296	0.85



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Cheaters try to hide when caught...

- Recrawl in October, 2011
- 43,465 non-cheaters now flagged as cheaters
- 13% had privacy setting change
 - Compared to a bit more than 3% of non-cheaters
- 10% from public to more restrictive setting
 - Compared to less than 3% of non-cheaters

...and for good reason: the community disapproves

Change in Degree		
	Cheaters	Non-cheaters
Net loss	44%	25%
Net gain	13%	36%
No change	43%	39%

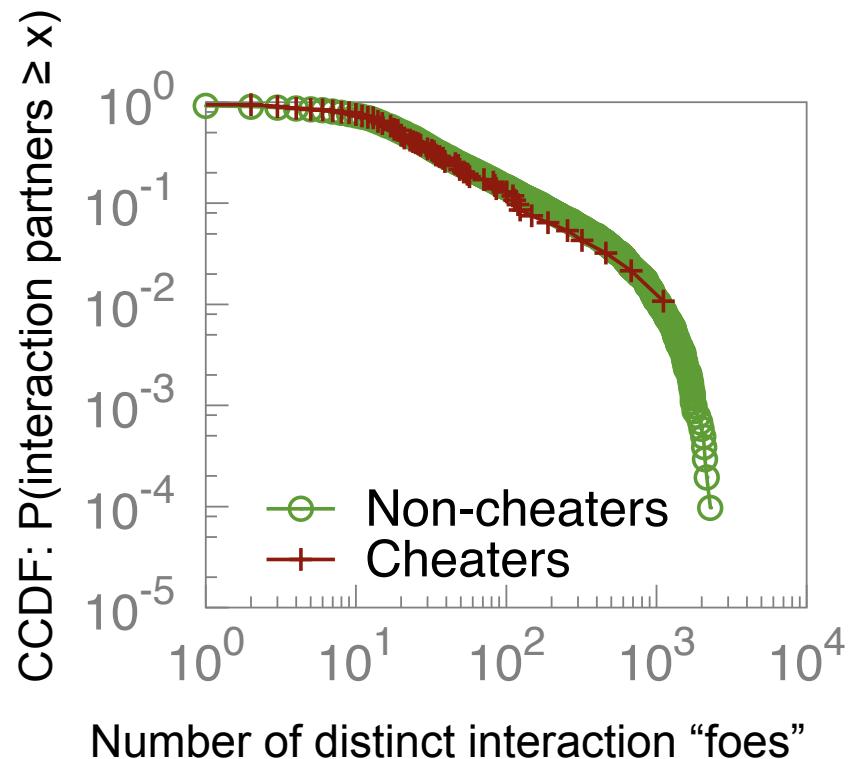
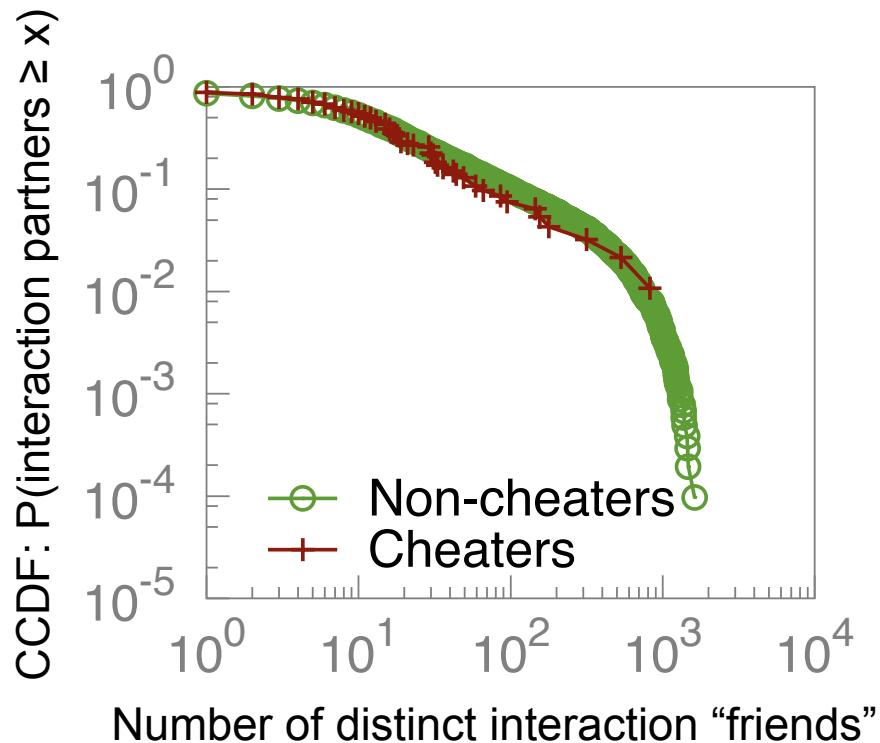
Cheaters tend to lose friends while non-cheaters tend to gain friends

Gameplay logs



- Team-based, objective oriented
 - Two teams, nine classes
 - “Friend” interactions
 - “Foe” interactions
- Popular TF2 server
 - VAC secured
 - Community owned
 - April 1 - June 8, 2011
- Interaction network
 - 10,354 players
 - 93 cheaters
 - 486,808 edges

Cheaters not mistreated in games



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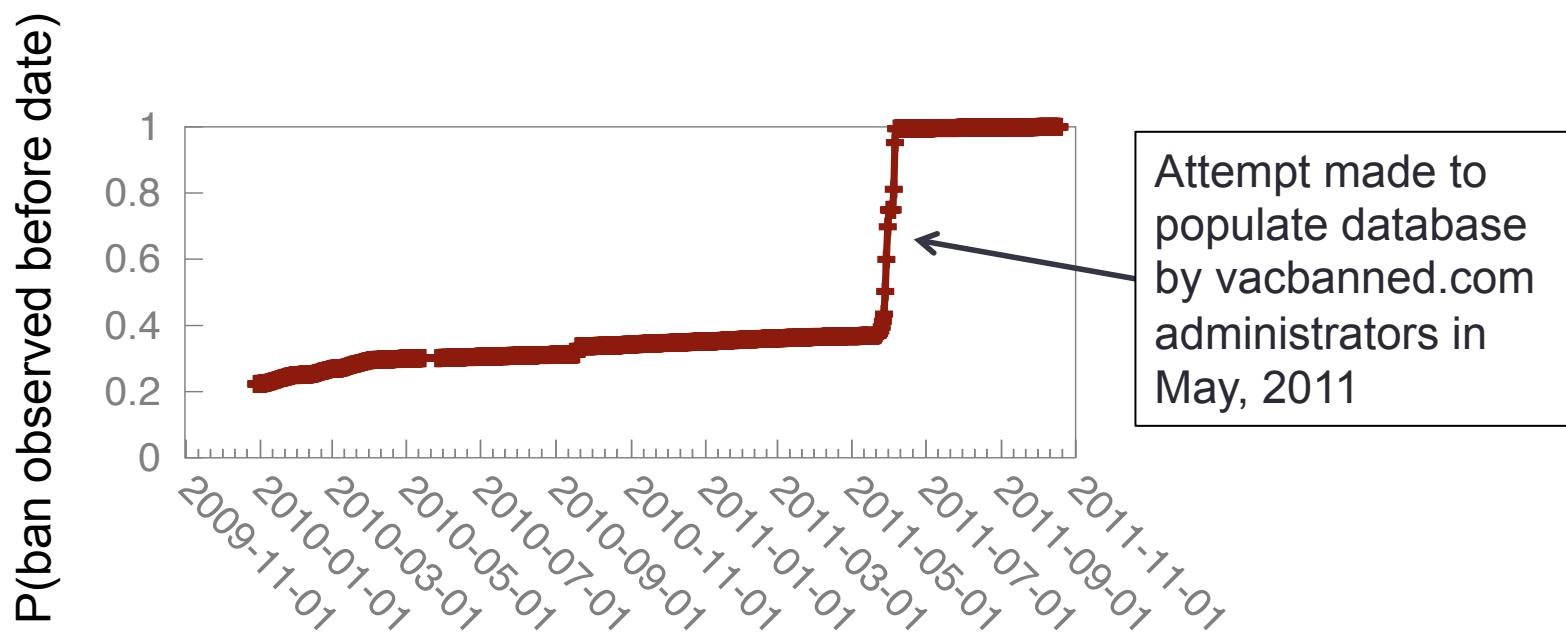
Does cheating spread over social links?

- Label nodes with the date of their VAC ban
- 180-day snapshots of the cheater status of nodes over time
 - For each snapshot, only those players whose ban date is from a previous snapshot are treated as cheaters

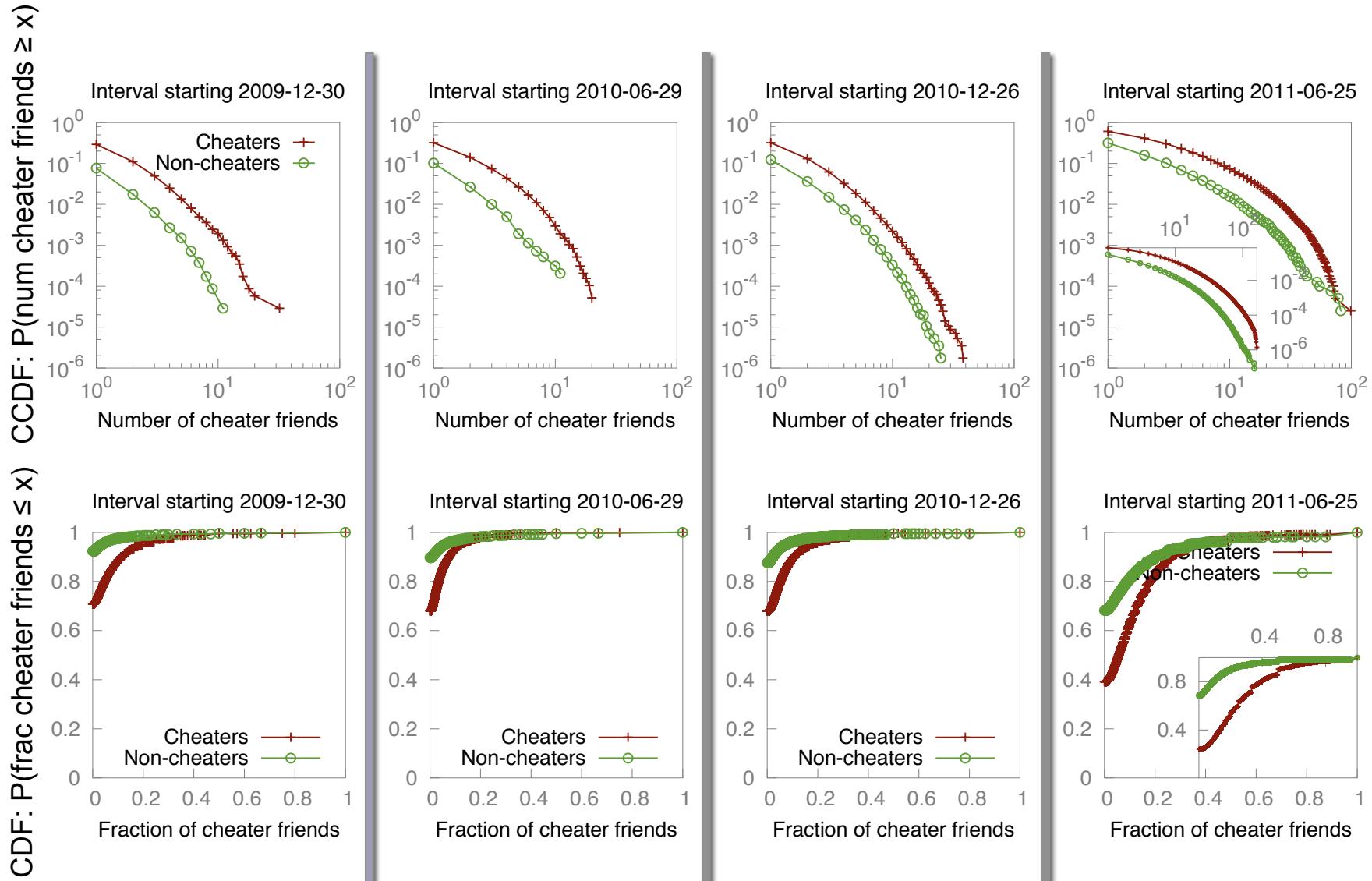
Do the neighborhoods for newly-marked cheaters differ from those of non-cheaters?

Historical ban dates

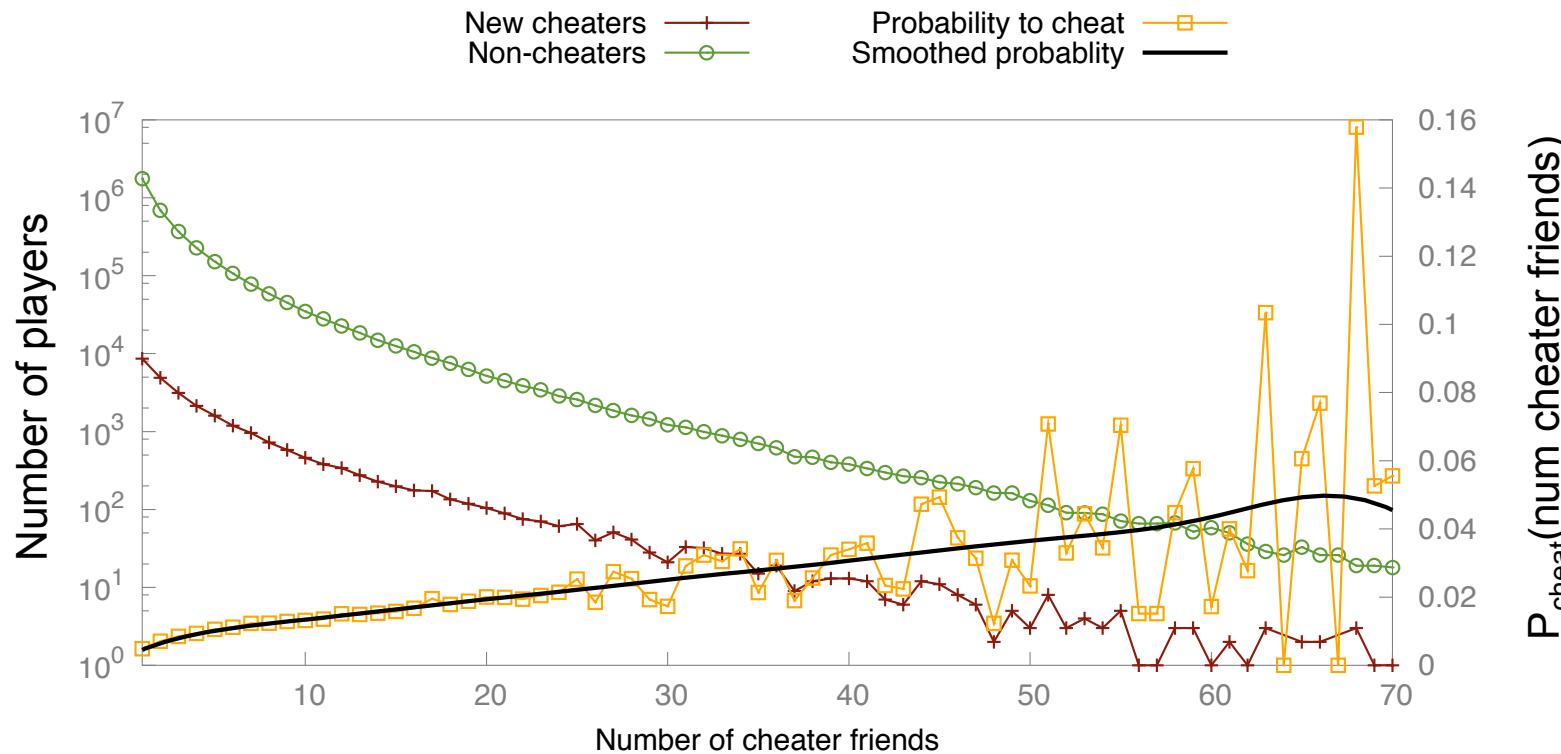
- 3rd party web site, vacbanned.com, provides historical data on when a VAC ban was first observed
 - Dates must be treated as banned “on or before”



Evolution of cheaters' social structure



Social ties as predictor of cheating



- Increasing probability of a player becoming a cheater as the number of cheaters in his social neighborhood increases*
- Decision tree classifier had ROCA of 0.61 based on number of cheater friends

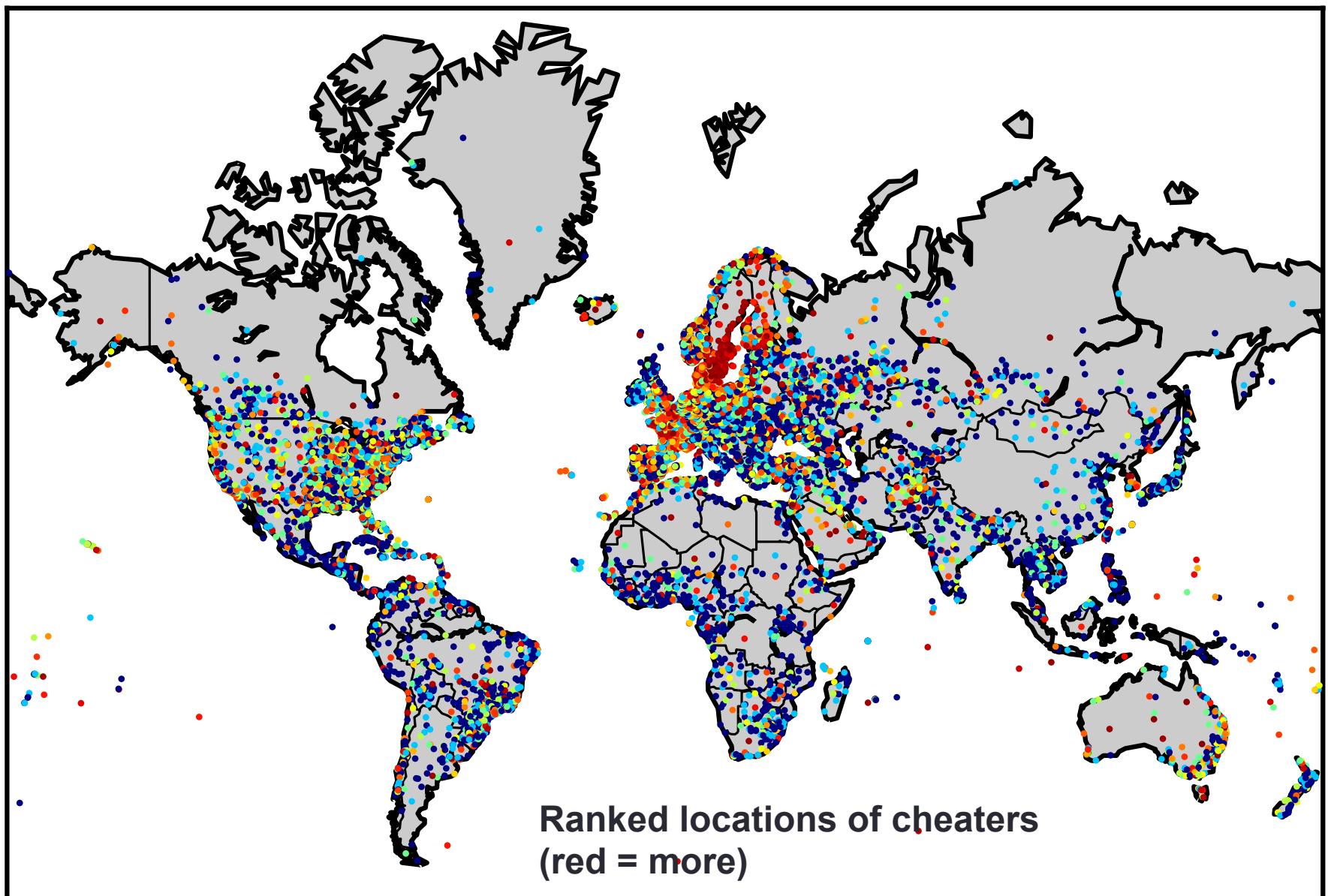
(*plot not in paper)

Summary of results

- Homophily between cheaters
 - Even though cooperation not necessary
- Cheaters' distribution not uniform
 - In social network
 - Geo-politically
- Cheaters face social penalty
 - But not in game
- Cheating behavior spreads via social links
 - Number of cheater friends predictor of future cheating

Impact

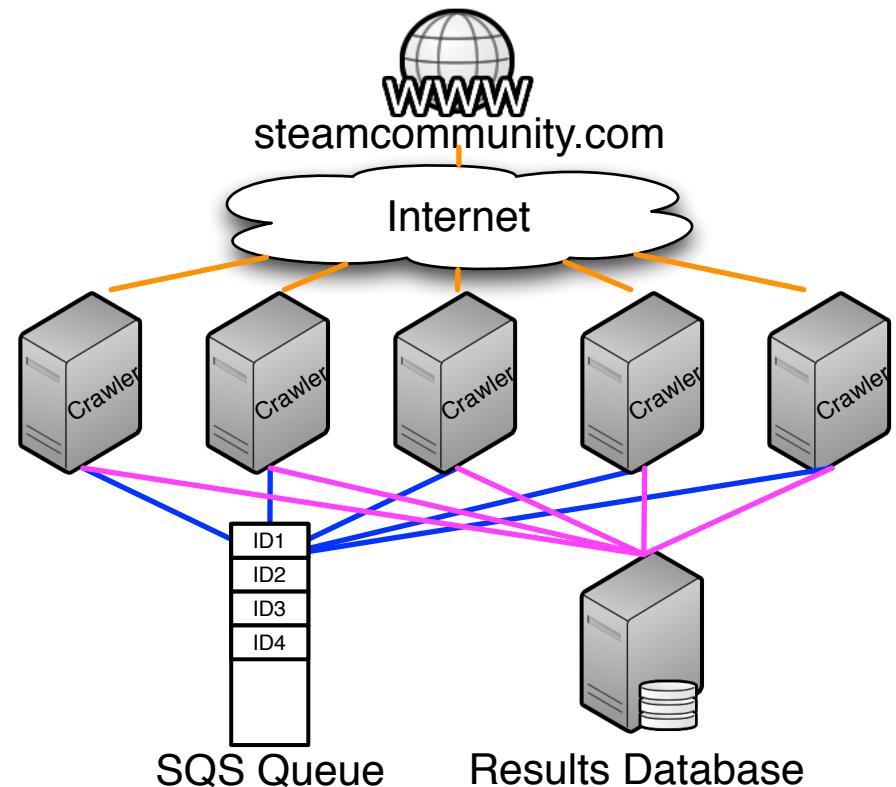
- Large scale study of unethical actors in online community
 - Correlation of unethical behavior and network structure
 - Useful for building models of unethical behavior
- Cheating is a *social problem*
 - Community serves out social punishment
 - Suggests exploring other social solutions for deviant behavior
- Scale of cheating of particular concern for gamified systems
 - Our study exposes a likely *lower bound* on cheating behavior
 - Social predictors can narrow focus to at-risk cheaters



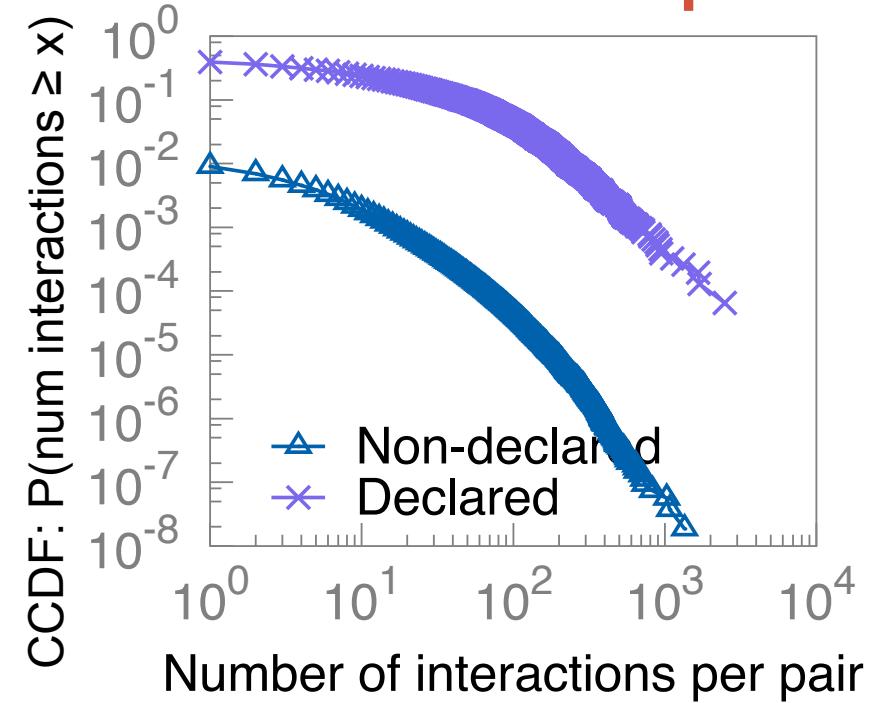
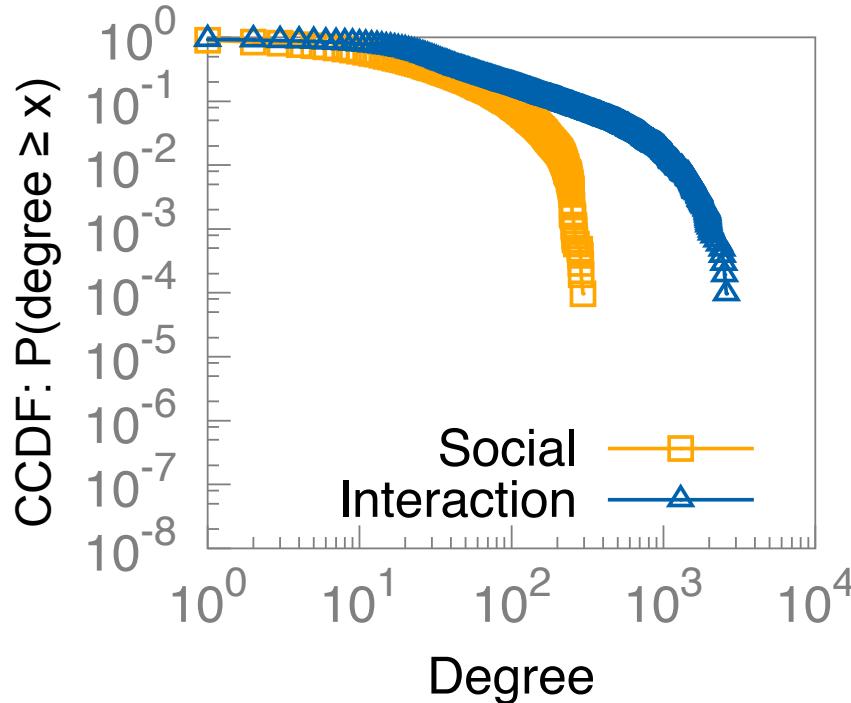
BACKUP SLIDES

Social Network Data Collection

- Distributed BFS
- 6,445 random seeds
- Up to 6 `m1.medium' instances
- Coordinated with Amazon SQS queue
- Two crawls
 - March 16th – April 3rd, 2011
 - October 18th – October 29th, 2011

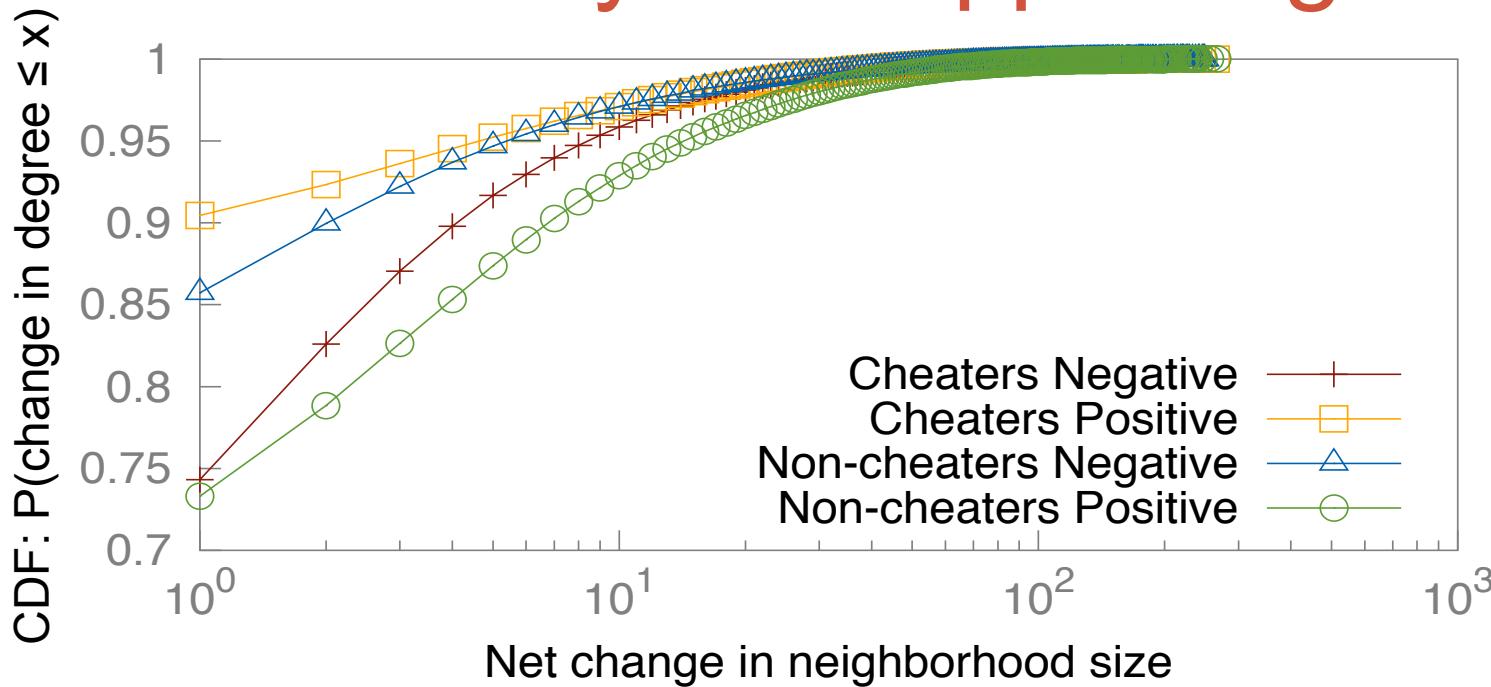


Interaction vs. declared relationships



- More interaction partners (even on a single server) than declared Steam friends
- **Steam Community friendships have meaning in-game**
 - Declared friends likely to have more interactions with each other than non-friends

The community is disapproving

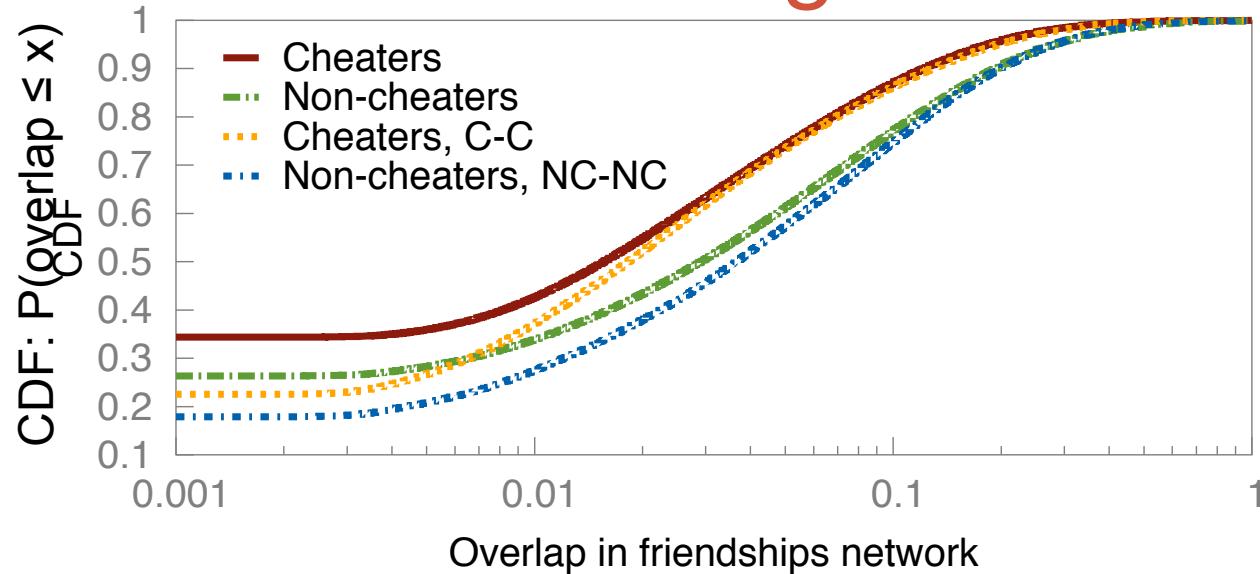


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Cheaters lost 2x the number of friends that they gained

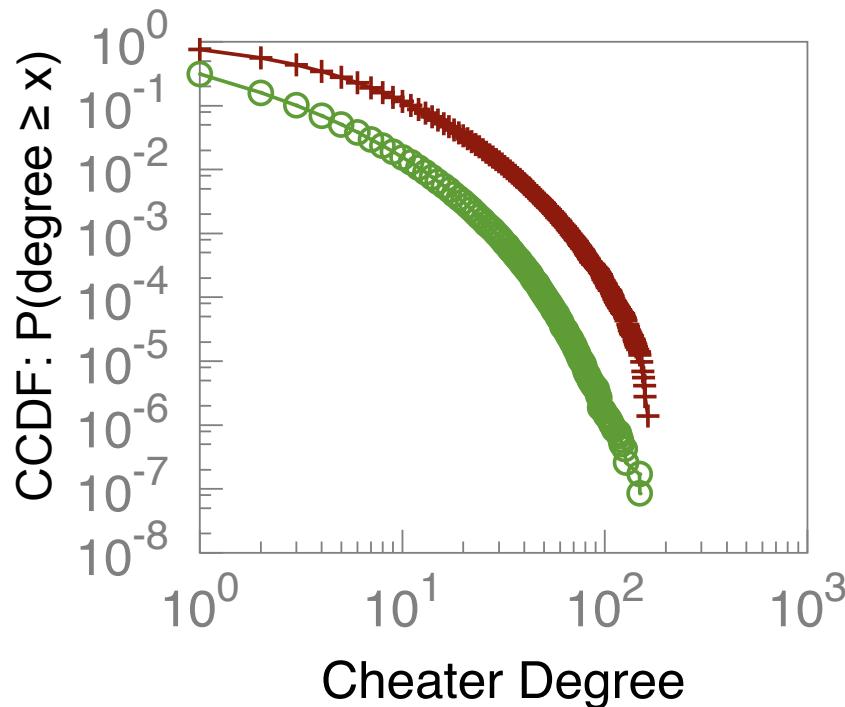
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Do cheaters form strong relationships?



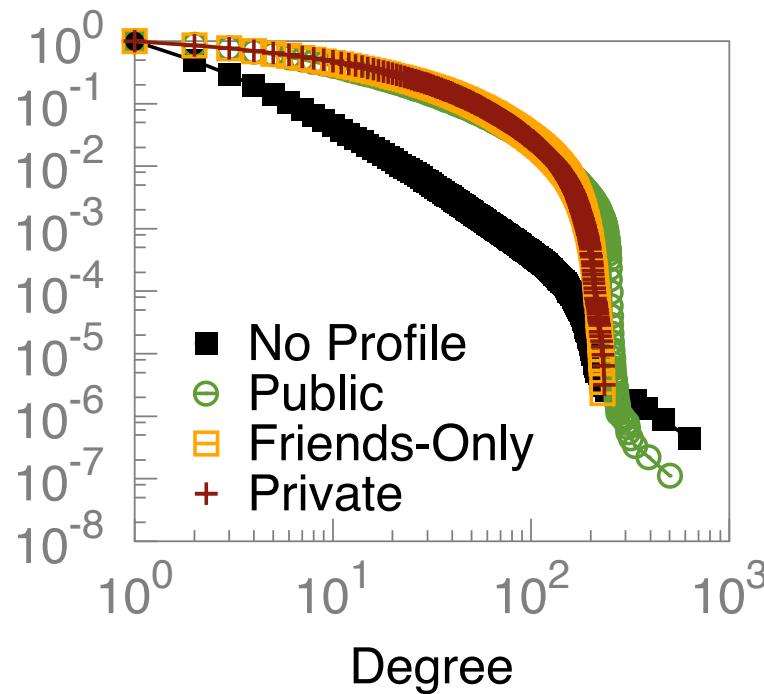
- Overlap between two neighborhoods is an indicator of social strength
- **Cheaters form stronger relationships with each other than with non-cheaters**
 - Overlap of cheater-cheater and non-cheater-non-cheater neighborhoods greater than overlap of mixed neighborhoods

Distribution of cheater friends



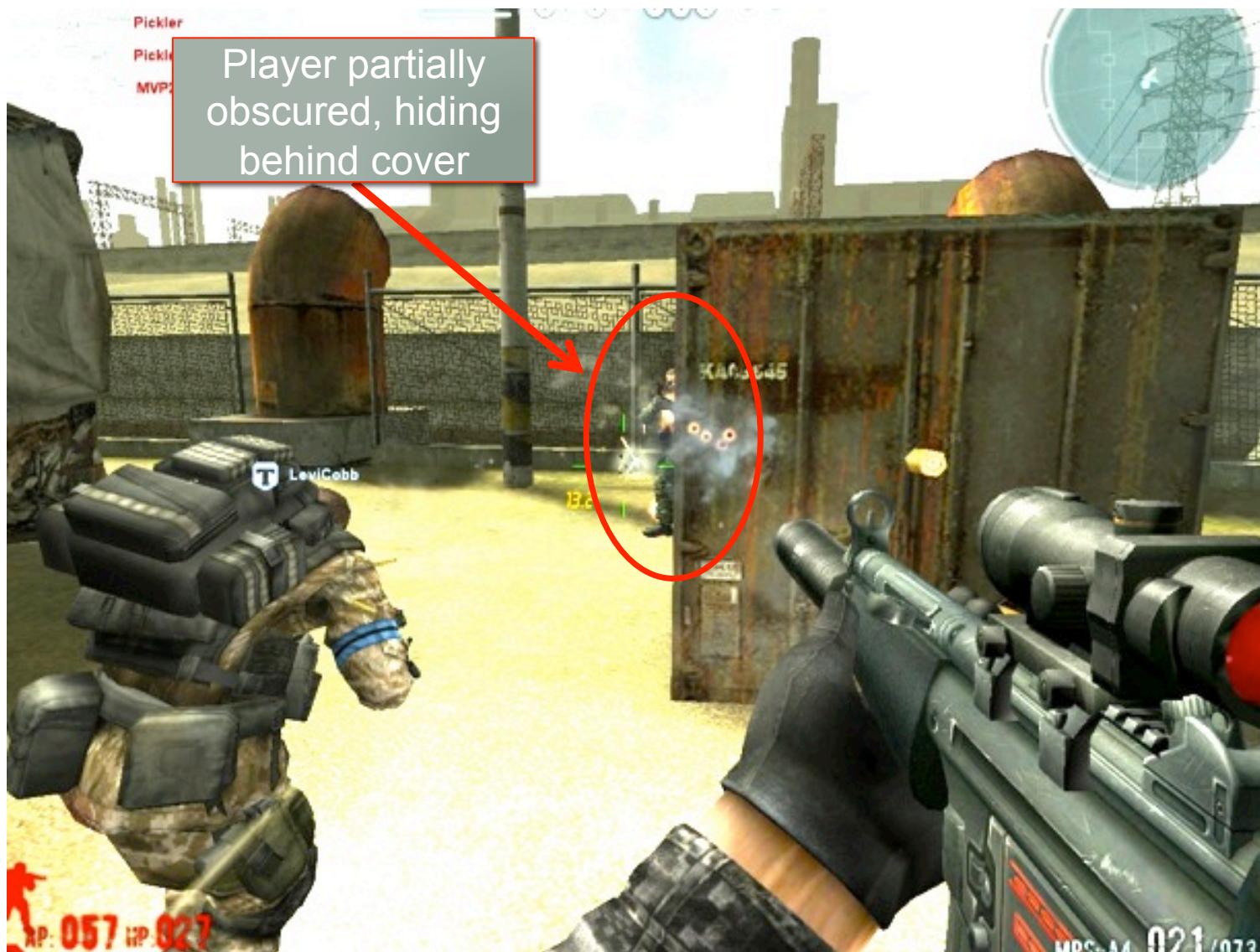
- Cheaters likely to have more cheater friends when compared to non-cheaters

Privacy settings and inferred degree



- Position in network inferable from your public friends

Real world cheat: Wallhack



Cheating behavior outside of gaming

- Academics
 - Plagiarism
 - Cheating on exams
- Personal relationships
 - Cheating on your spouse
- Real-world crime
 - Confidence scams
- Minor law breaking
 - Speeding
- Real-world sports
 - Steroids
 - “Diving” in soccer
- Cyber crime
 - Spam
 - Malware distribution
- Business
 - Accounting fraud
 - Corporate espionage