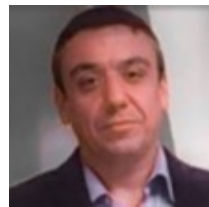


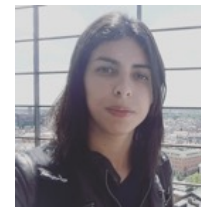
# Temporal Graph Mining for Fraud Detection Part I



*Christos Faloutsos*  
*CMU*



*Pedro Fidalgo*  
*Mobileum*



*Mirela Cazzolato*  
*USP*



## Bird's eye view

- Part#1: Introduction – types of fraud
- Part#2: Graphs Mining – patterns and tools
- Part#3: Visualization - conclusions

# 'Recipe' Structure:

- Problem definition
- Short answer/solution
- LONG answer – details
- Conclusion/short-answer



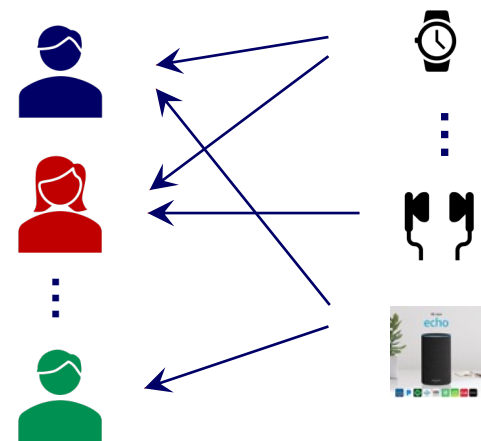
# Graphs are everywhere!

- E-commerce
- Social networks
- Cyber-security
- Bio-informatics
- ...



# e-commerce examples

Who-buys-what

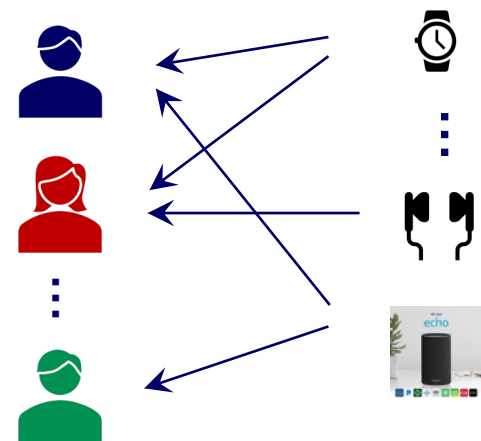


# e-commerce examples

Who-buys-what

Who sells what

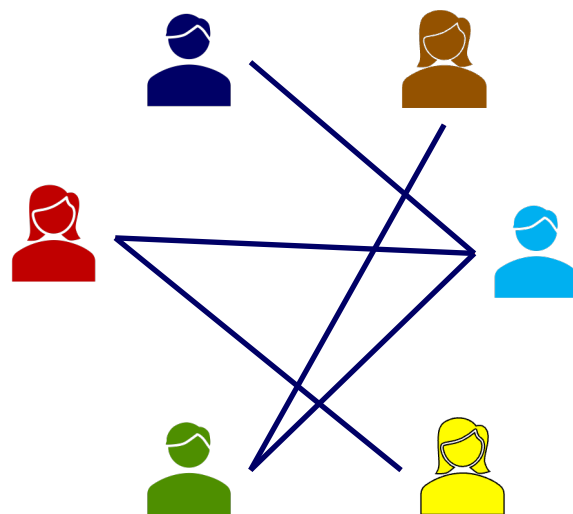
Who reviews what



# Social networks



Who-friends-whom



# Social networks

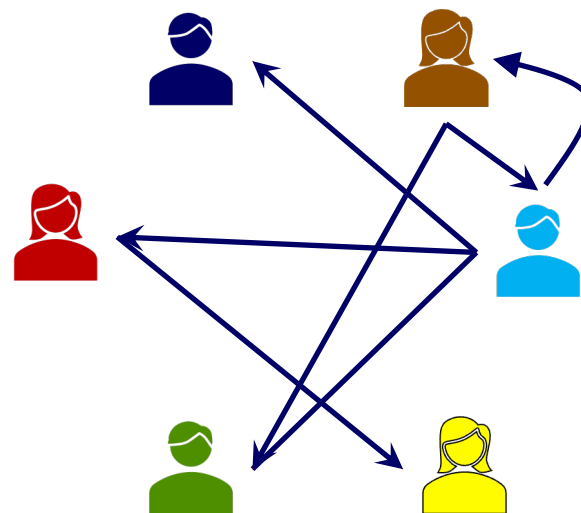


Who-friends-whom



Who-follows-whom

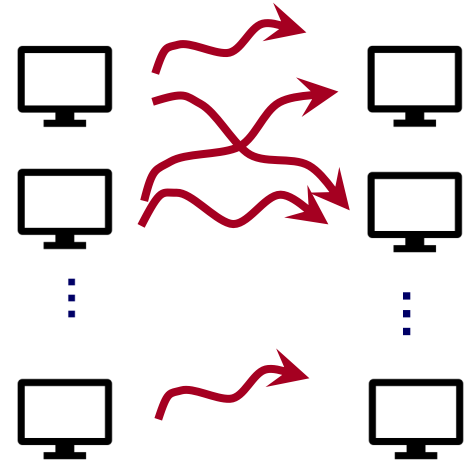
Who-retweets-whom





# Cyber-security

Who-buys-what  
Who-sells-what  
Who-reviews-what



Which\_machine - connects\_to - what 

...

<subject> related-to <object> : graph

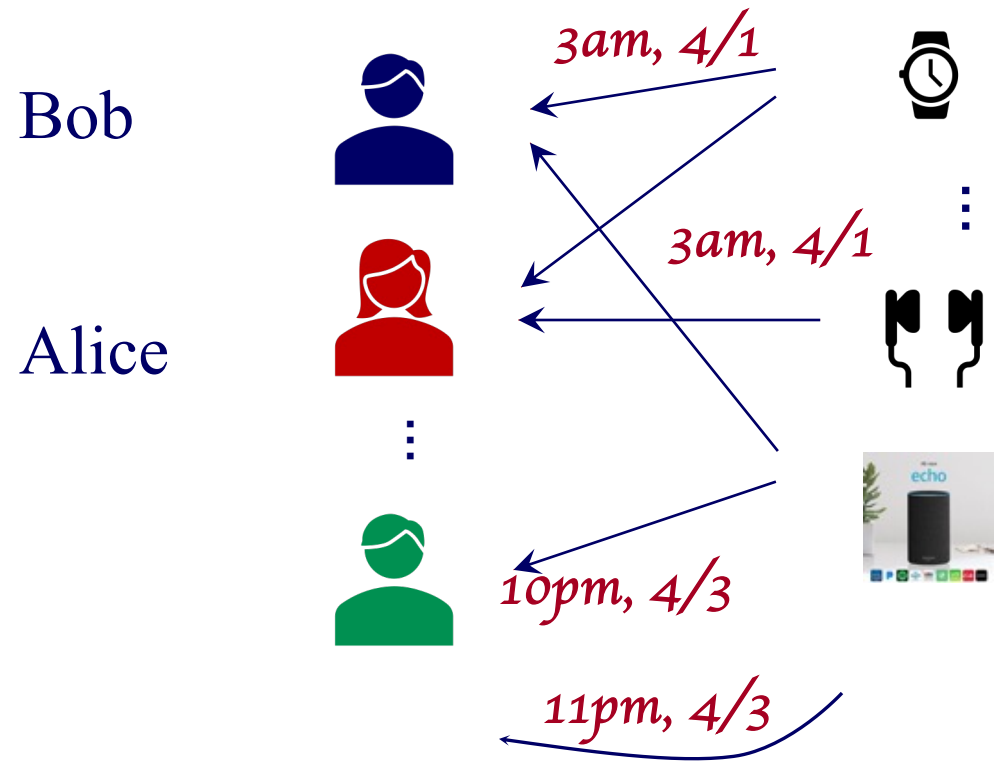
# Biology/medicine

- Protein-protein interaction networks
- Drugs and side-effects
- Symptoms and disease



# Time-evolving graphs

- What is 'normal'? suspicious? Groups?





## Bird's eye view

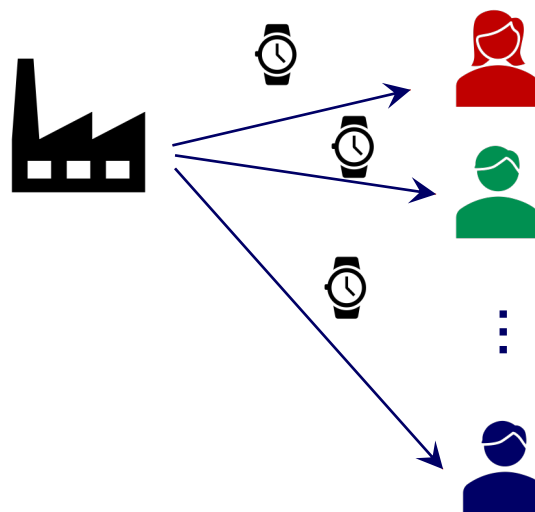
- Part#1: Introduction - motivation
  - Types of fraud
- Part#2: Patterns and tools
  - Static graphs
  - Time evolving graphs
- Part#3: Visualization - Practitioner's guide
- Conclusions

## (multiple) types of fraud

- F1) E-commerce
- F2) Social networks
- F3) Phone-call graphs
- ...

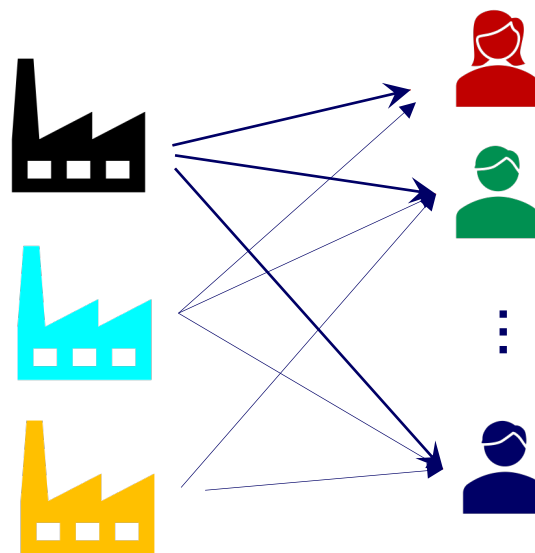
# F1: Fraud in e-commerce

- ‘brushing’ ([Wikipedia](#); [WSJ](#))
  - Un-wanted packages, to boost ‘sales’



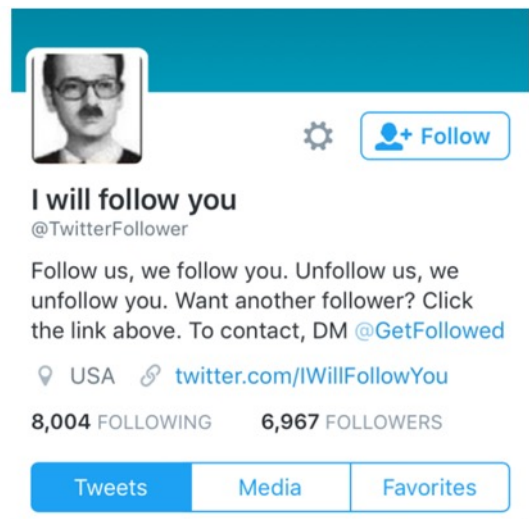
# F1: Fraud in e-commerce

- ‘brushing’ ([Wikipedia](#); [WSJ](#))
  - Un-wanted packages, to boost ‘sales’
- Buyer-seller collusion
- ...



# F2: Fraud in social networks

- Fake twitter followers

**I will follow you**  
@TwitterFollower

Follow us, we follow you. Unfollow us, we unfollow you. Want another follower? Click the link above. To contact, DM @GetFollowed

USA [twitter.com/IWillFollowYou](https://twitter.com/IWillFollowYou)

8,004 FOLLOWING    6,967 FOLLOWERS

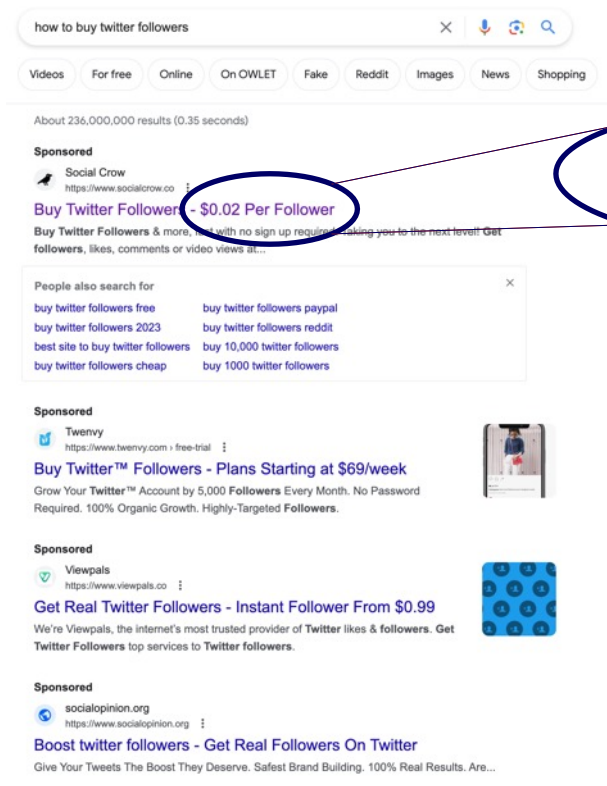
Tweets    Media    Favorites



**I will follow you** @TwitterFoll... 7/24/09

Check out how I got 500 followers in ONE day! <http://www.extrafollowers.com>

20    13



how to buy twitter followers

Videos    For free    Online    On OWLET    Fake    Reddit    Images    News    Shopping

About 236,000,000 results (0.35 seconds)

**Sponsored**  
Social Crow  
<https://www.socialcrow.co>  
**Buy Twitter Followers - \$0.02 Per Follower**  
Buy Twitter Followers & more... with no sign up required... making you to the next level! Get followers, likes, comments or video views at...

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**Sponsored**  
Twenvy  
<https://www.twenvy.com> - free-trial  
**Buy Twitter™ Followers - Plans Starting at \$69/week**  
Grow Your Twitter™ Account by 5,000 Followers Every Month. No Password Required. 100% Organic Growth. Highly-Targeted Followers.

**Sponsored**  
Viewpals  
<https://www.viewpals.co>  
**Get Real Twitter Followers - Instant Follower From \$0.99**  
We're Viewpals, the internet's most trusted provider of Twitter likes & followers. Get Twitter Followers top services to Twitter followers.

**Sponsored**  
socialopinion.org  
<https://www.socialopinion.org>  
**Boost twitter followers - Get Real Followers On Twitter**  
Give Your Tweets The Boost They Deserve. Safest Brand Building. 100% Real Results. Are...

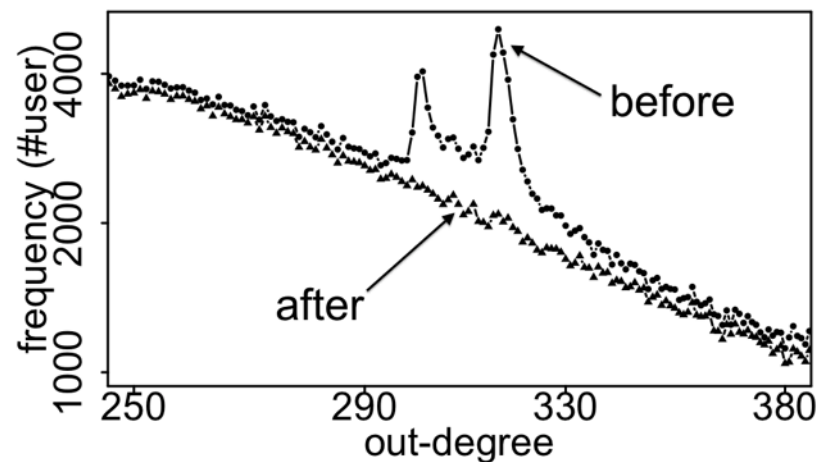
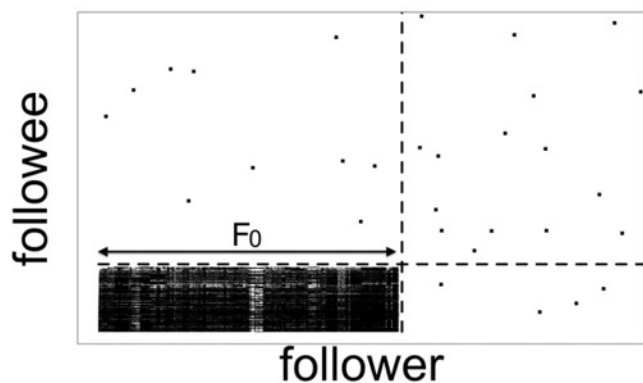
**\$0.02 Per Follower**



# F2: Fraud in social networks



“Block”

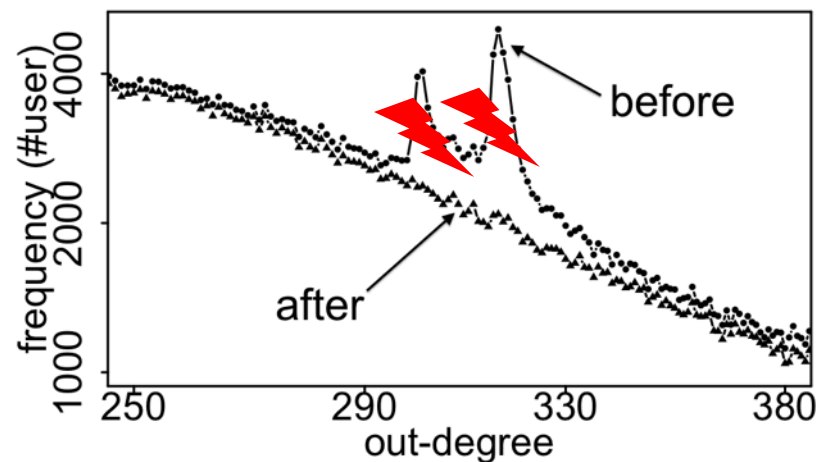
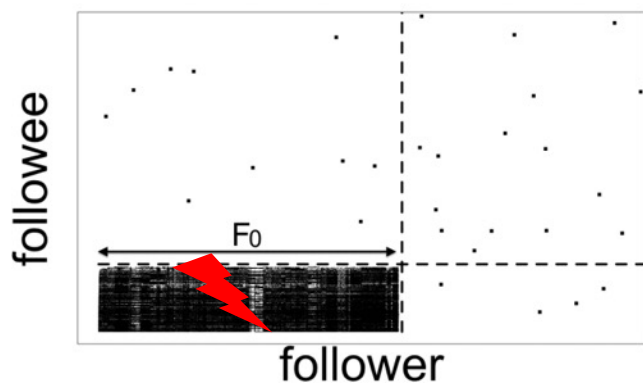


*Inferring Strange Behavior from Connectivity Pattern in Social Networks*; Meng Jiang, Peng Cui, Shiqiang Yang, Alex Beutel, Christos Faloutsos; PAKDD'14

# F2: Fraud in social networks



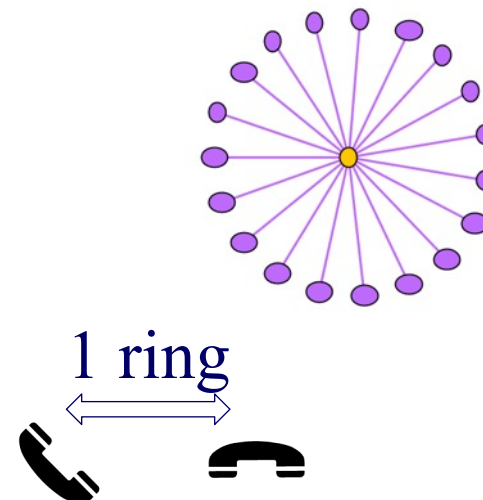
“Block”



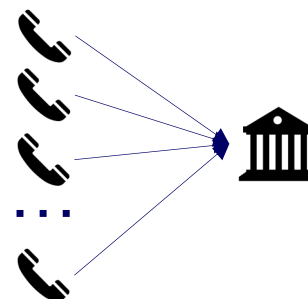
*Inferring Strange Behavior from Connectivity Pattern in Social Networks*; Meng Jiang, Peng Cui, Shiqiang Yang, Alex Beutel, Christos Faloutsos; PAKDD'14

## F3) Phonecall graphs

- Telemarketers
- ‘wangiri’ ‘one-ring scam’
  - [Europol](#); [AT&T](#)



- Telephony Denial of Service ([DHS](#))

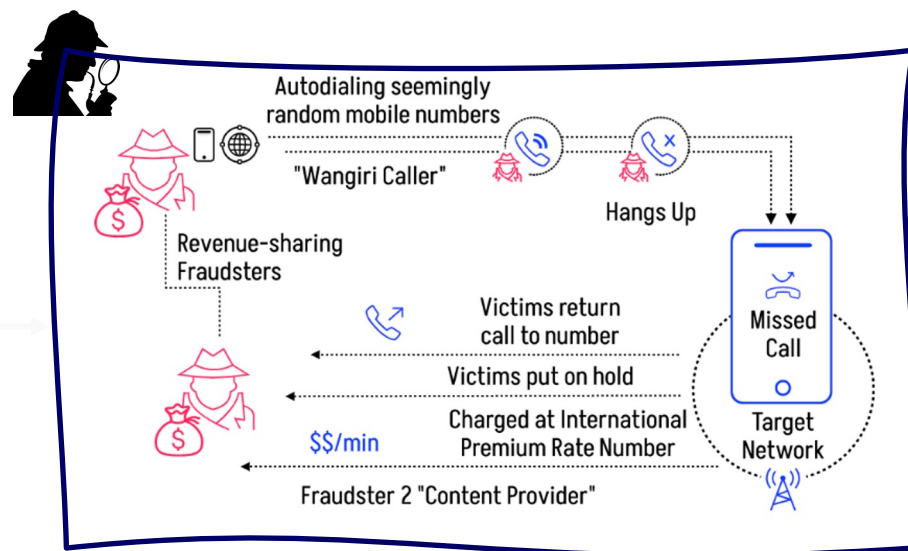


# Fraudulent Behavior: "Know Thy Enemy"

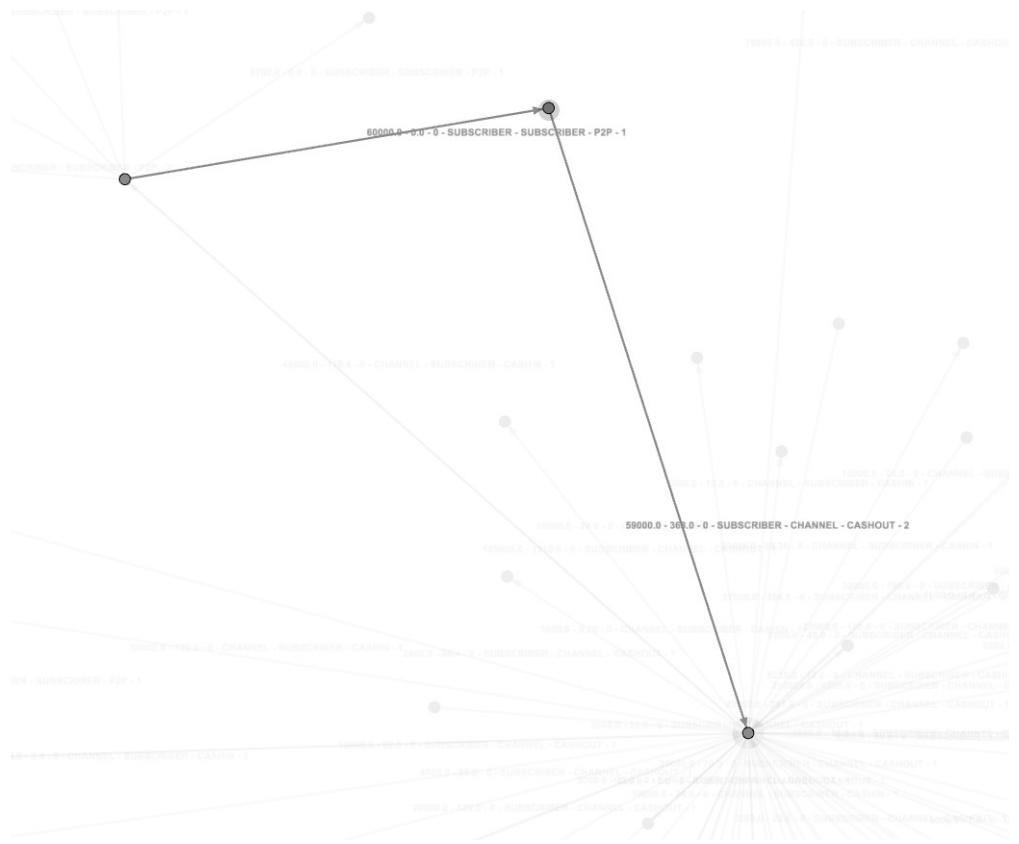


**Indicator signs** for some of the fraudulent behaviors.  
 +(/-) means abnormally high(/low).

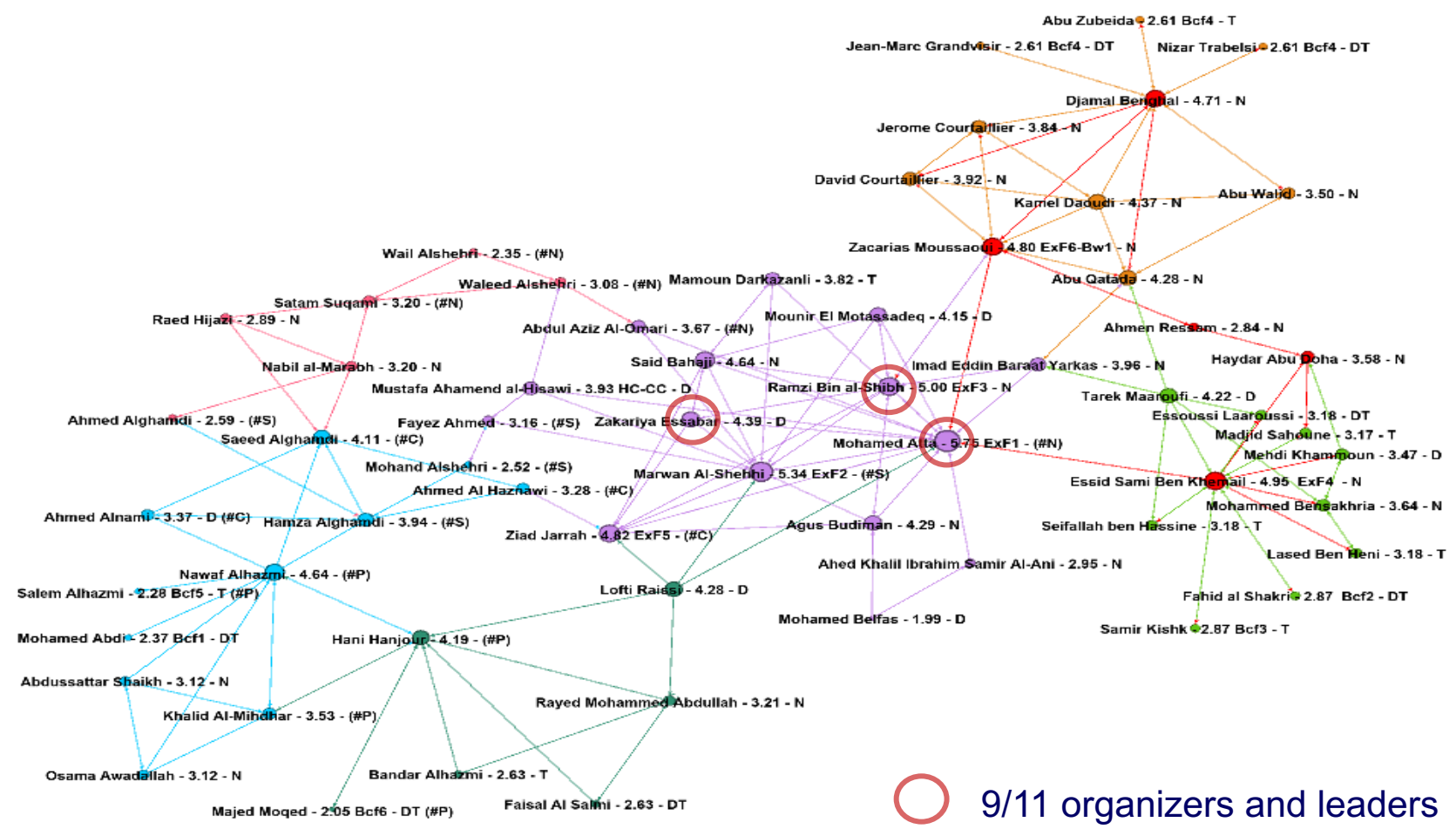
	<i>out-degree</i>	<i>in-degree</i>	<i>in-weighted-deg.</i>	<i>out-weighted-deg.</i>	<i>in-call-count</i>	<i>out-call-count</i>	<i>IAT</i>	<i>density</i>
<b>Fraud Type</b>								
Revenue Share (IRSF)	+	-	-	+		+		
Arbitrage	+	-	-	+		+	-	+
Voice Interconnect Bypass	+		-		-	+	-	+
<b>Fraud Method</b>								
CLI Spoofing	+			+				-
Wangiri	+			+		+		
Robocalling	+	-		+				+



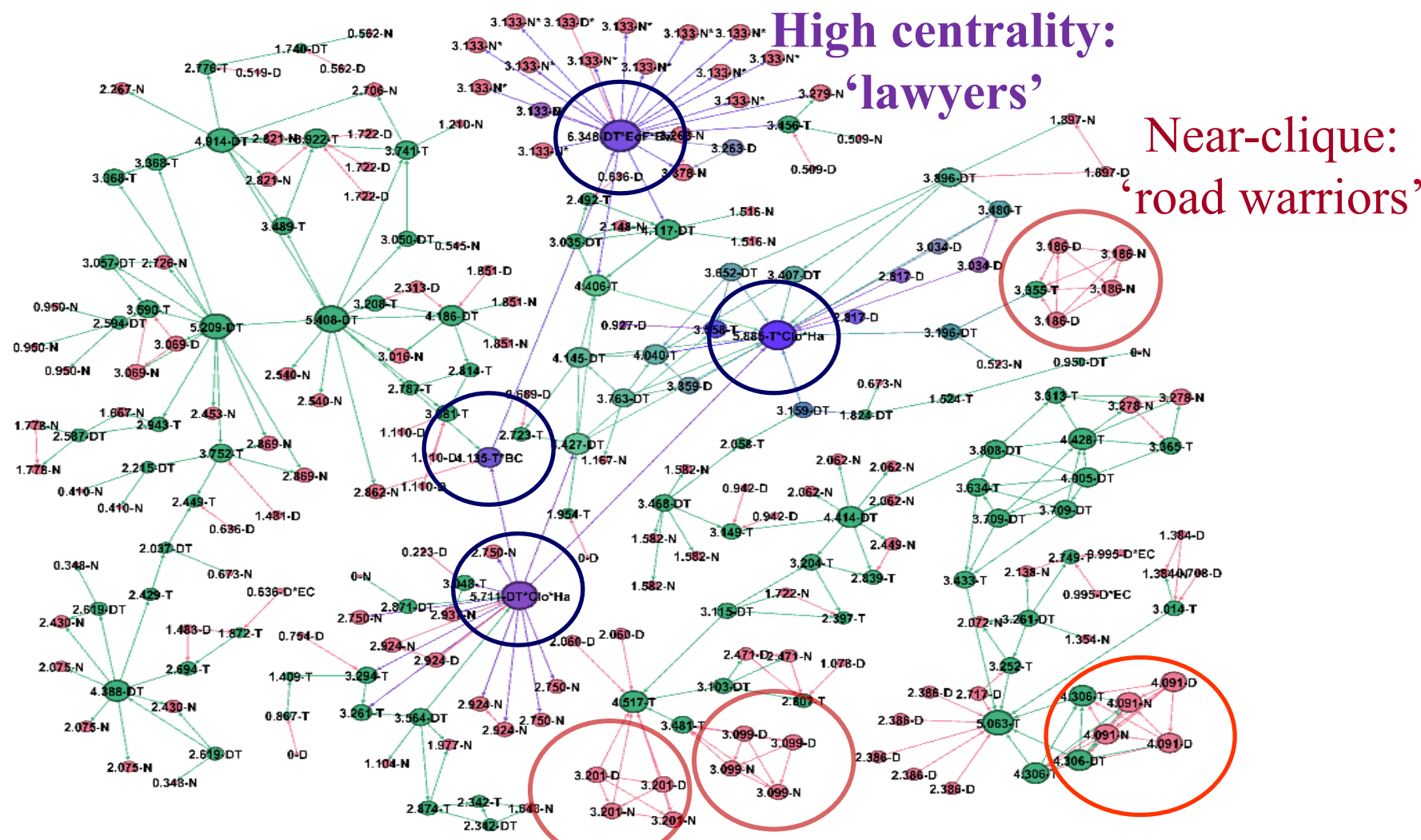
# F4) Money Laundry



# F6) Terrorism Networks (9/11)

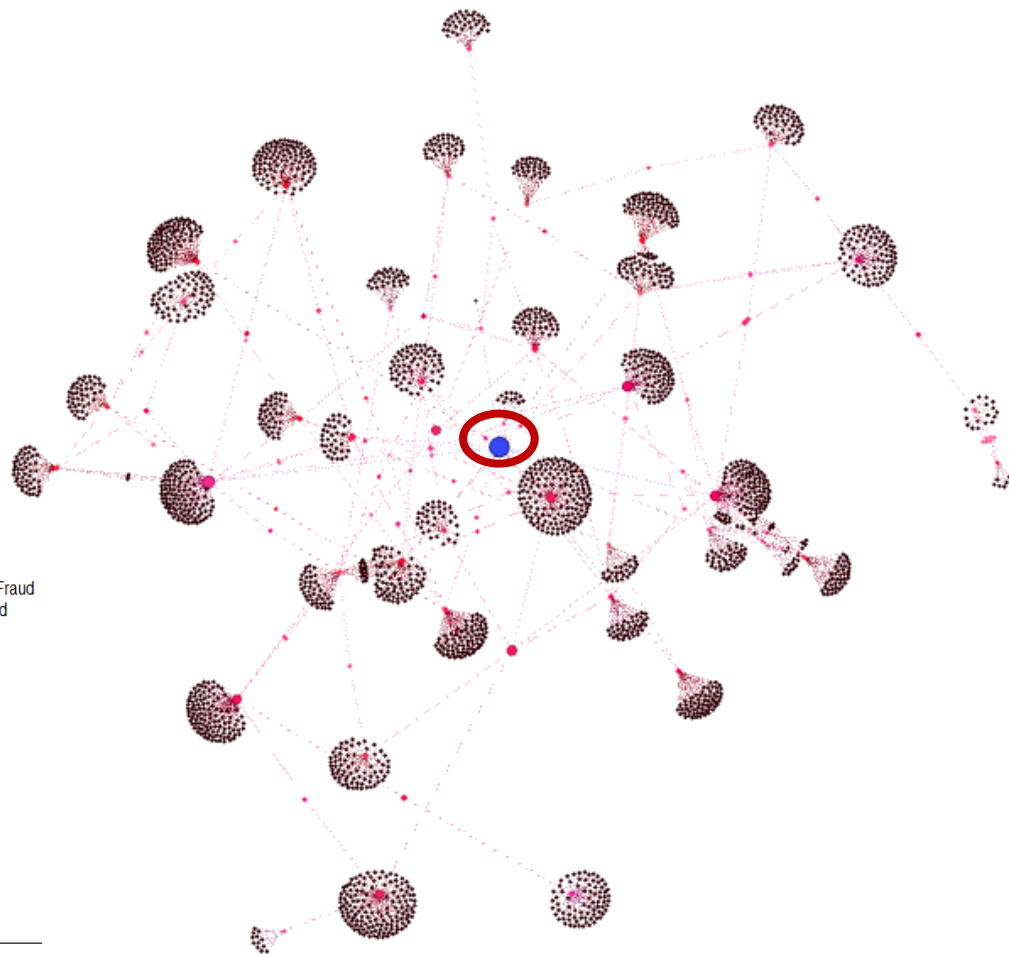
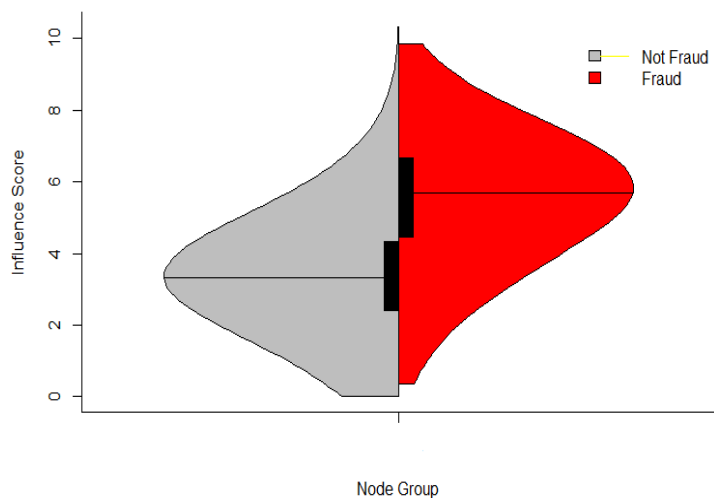


# F5) Criminal Associations (BFP)



# F5) Telecom Fraud (Credit Cards)

- Bridge nodes with low degree
- Interconnected Hubs
- Strategic position
- High Influence
- Roles in the network (Control)





## (multiple) types of fraud

- F1) E-commerce
- F2) Social networks
- F3) Phone-call graphs
- F4) Financial Fraud
- F5) Money Laundering
- ...