

# *The Socio-monetary Incentives of Online Social Network Malware Campaigns*

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# Tech “Virus” x Bio Virus

*In 1983 Cohen uses the term “virus” to describe a self-replicating computer program*

*“Recently” added: Viral Marketing, Memes (1976), Viral Videos*

self-replicating	✓	✗	✓
mutates to fool defenses	✓	✓ ✗	✓
cope with diverse “gene” pool	✗	?	✓

# OSN Malware

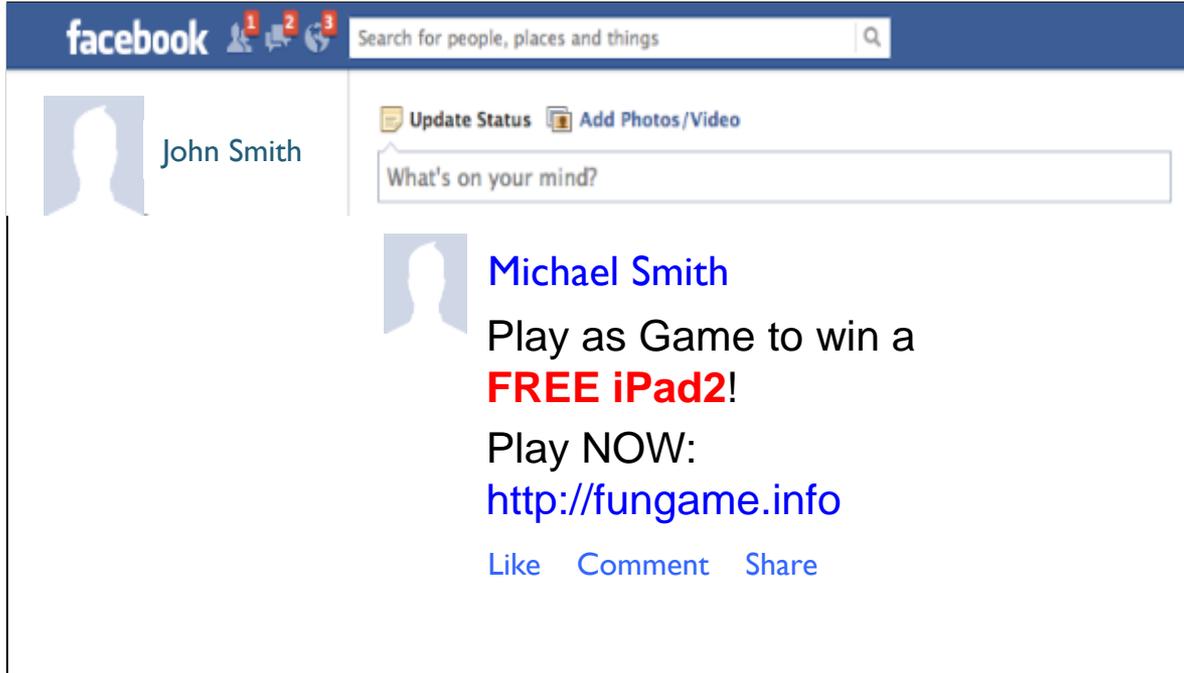
	Computer virus	Internet "viral"	Biological virus
self-replicating	✓	✗	✓
mutates to fool defenses	✓	✗	✓
cope with diverse gene pool	✗	?	✓



self-replicating	-	✓
mutates to fool defenses	-	✓
cope with diverse gene pool	-	✓

# OSN Malware replication

- ▶ Spreads through clickjacking



## OSN Malware

self-replicating

x

mutates to fool defenses

?

copies with diverse gene pool

?

# OSN Malware mutations

- ▶ Text Obfuscation to fool Facebook's spam detection engine



OSN Malware

self-replicating



mutates to fool defenses



cope with diverse gene pool



# What makes people click on posted links?

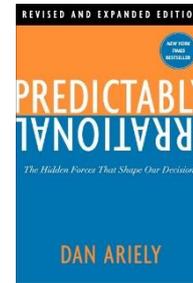
- ▶ What makes someone retweet?
- ▶ What makes people forward videos?

*Understanding **what drives** OSN malware cascades  
may help us create better models*

# What makes people do things?

## Behavioral Economics has answers

- ▶ *BE studies what gets people to do something*
- ▶ Heyman & Ariely Labor Markets
  - Social incentives
  - Monetary incentives



The image is a screenshot of a Facebook interface. At the top, there is a blue navigation bar with the 'facebook' logo and a search bar. Below the navigation bar, there is a profile card for 'John Smith' with a placeholder profile picture and a text input field for 'What's on your mind?'. Below the profile card, there is a post by 'Michael Smith'. The post text reads: 'Play a Game to win a FREE iPad2! Play NOW: http://fungame.info'. Below the text are the interaction buttons 'Like', 'Comment', and 'Share'. A red arrow points from the text 'monetary incentive' to the 'FREE iPad2!' part of the post.

monetary  
incentive

# Heyman & Ariely Labor Markets

- ▶ [Heyman & Ariely, 2004] experiments:
  - Social incentive (“get friends to work for you”)
  - Monetary incentive (“pay people to work for you”)
  - What about mixed socio-monetary incentives?



+



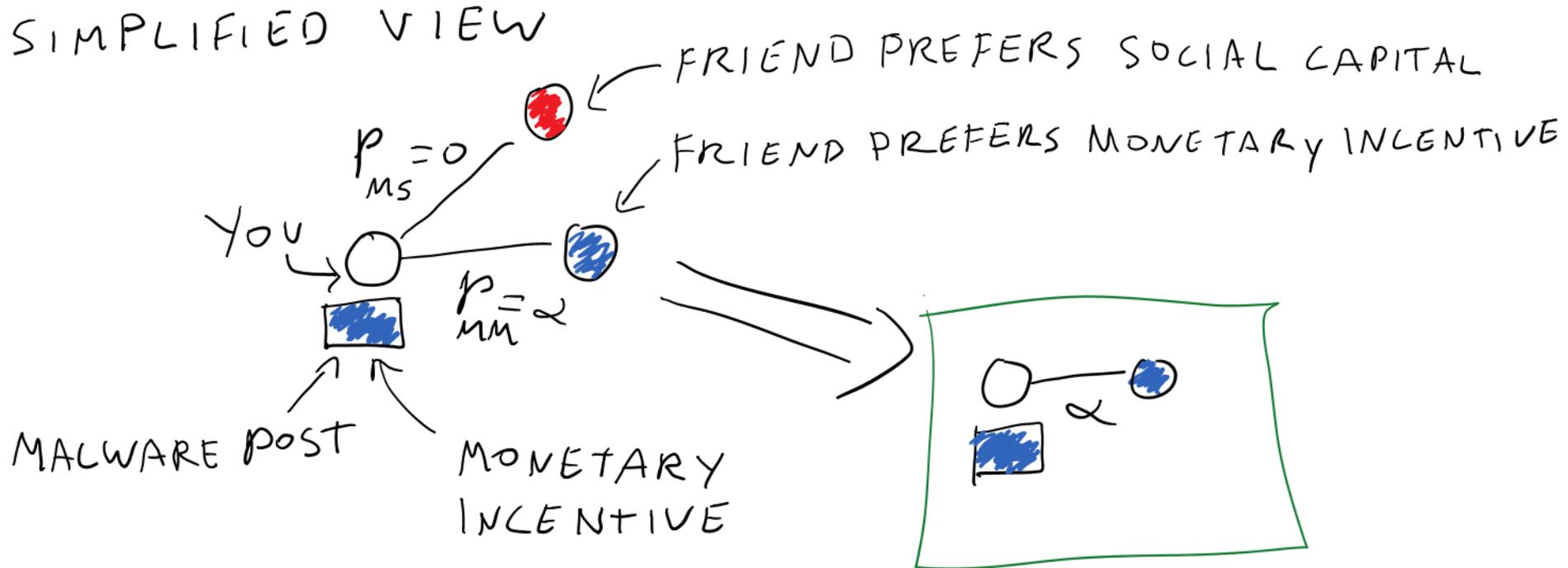
Money speaks  
louder than  
social capital



Socio-monetary incentive  $\approx$   
Monetary incentive

# A Labor Market view of malware cascades

SIMPLIFIED VIEW

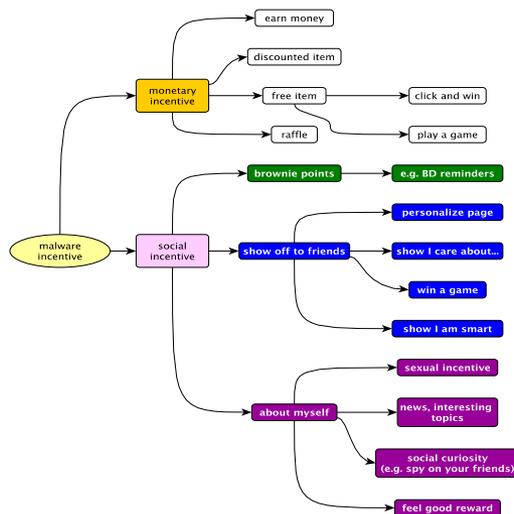


# Classifying Facebook malware incentives

## Our Facebook data:

- 111 million posts
- **164,000** malware posts
- **3,100** distinct malware campaigns  
(campaign defined through URL of attack)
- **From 07/2011 to 04/2012**

## ► Mechanical Turk to classify incentives



This questionnaire is part of a research project. By choosing this HIT you agree to participate in our research by answering the following questions to the best of your knowledge. The following messages are true Facebook posts. Help us classify them.

**Instructions:** You must choose one option for each of the following questions. Some options have sub-options that must also be chosen. After finishing all questions hit "Submit" to advance.

1. Which economic incentive is given to click on the link?

No economic incentive

Free item( click-and-win or by playing a game)

Rebate, Discounted item

Raffle (Lottery)

Earn money

2. Which non-economic incentive is given to click on the link?

No non-economic incentive

A chance to support something or to show I care about something (e.g. sport team, animals, etc.)

Compete or outdo my friends

Show good-will or get social points

Personalize and make my facebook page "cooler"

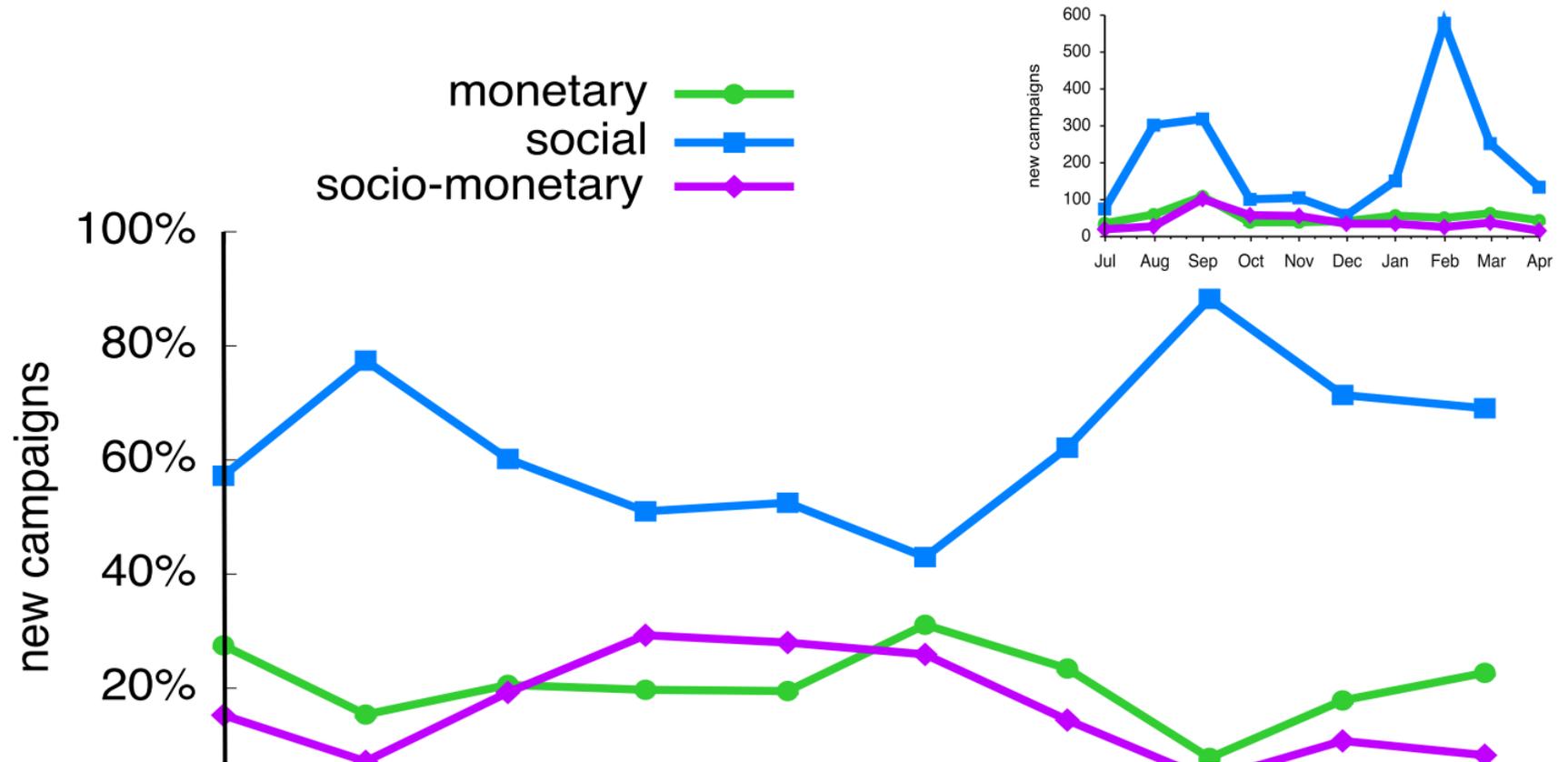
Other non-economic incentives

# Malware incentives

## classifying the incentives in malware posts

- ▶ *“Some People will dominate all the games and some are doomed to remain losers their whole life (sic): [link](#)”*
  - **social incentive**
- ▶ *“NEW GAME NOTICE! Come check out the awesome new contest that is available, you could win a Kindle Fire. Start playing[\(here\)](#)”*
  - **monetary incentive**
- ▶ “CONTEST UPDATE: Currently in 10246th place in The Daily Addi’s Gem Swap II contest to win a 16GB iPad2. Think you can do better? You should give it a try [\(here\)](#)”
  - **socio-monetary incentive**

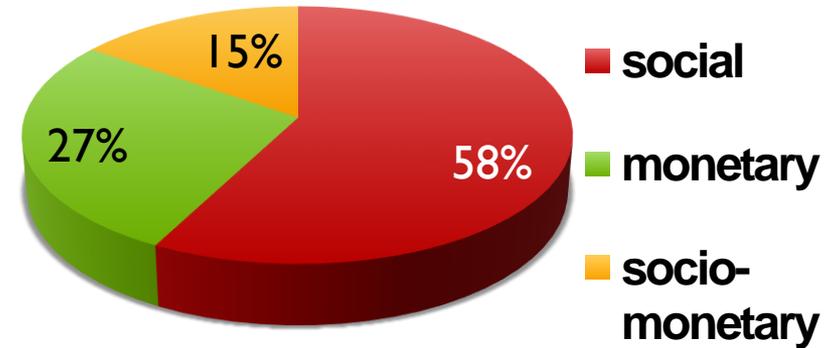
# Results: “Social” is favorite incentive of developers



# Facebook incentive popularity

Developers may know something?!

## New malware campaigns (07/2011)



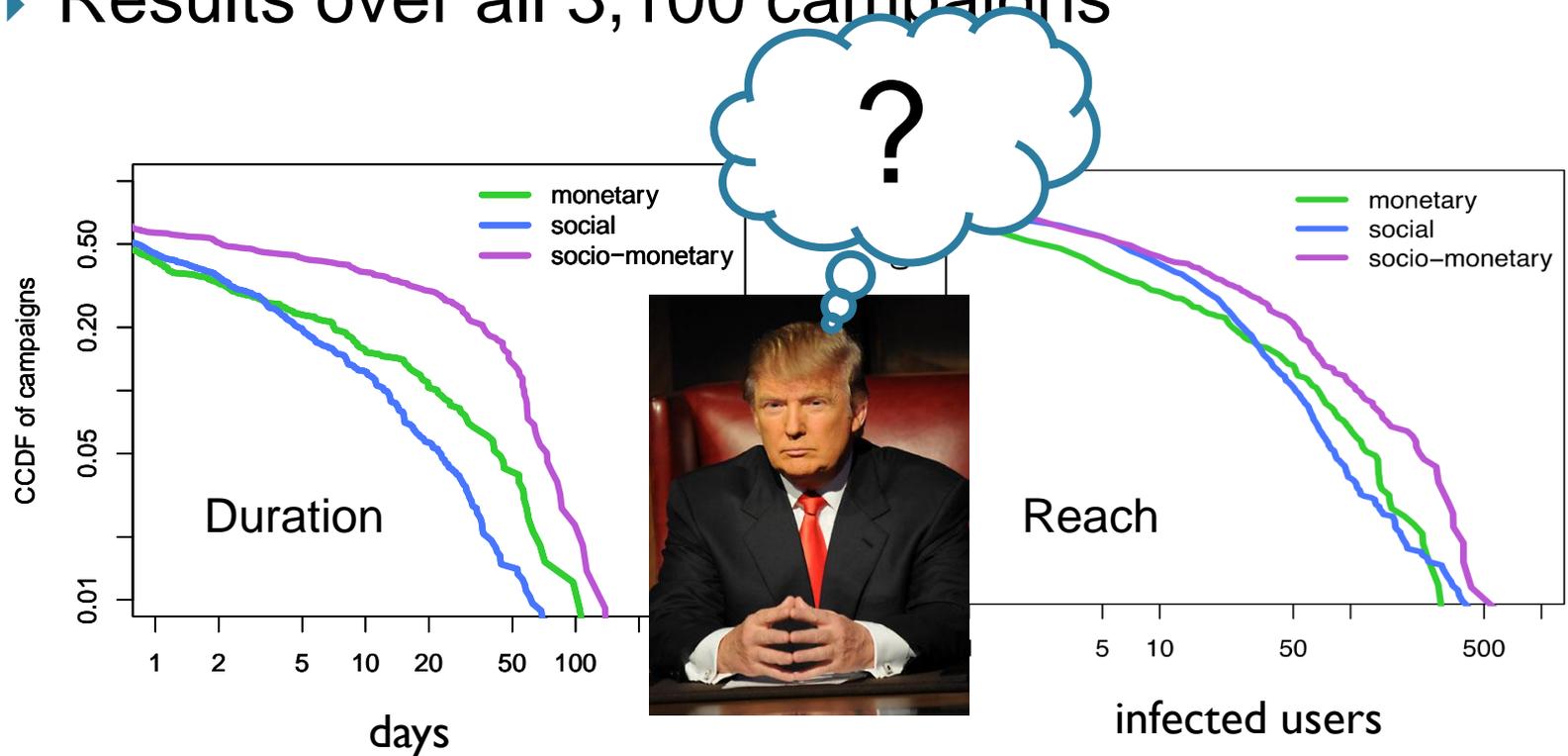
## Illustrative examples:

incentive	infections per campaign	sample post content
social (game)		Some People will dominate all the games and some are doomed to remain losers their whole life ( <i>sic</i> ): <a href="#">link</a>
monetary (game)		NEW GAME NOTICE! Come check out the awesome new Wild Wild Taxi contest that is available, you could win a Kindle Fire. Start playing <a href="#">here</a>
socio-monetary (game)		CONTEST UPDATE: Currently in 10246th place in The Daily Addi's Gem Swap II contest to win a 16GB iPad2. Think you can do better? You should give it a try <a href="#">here</a>

**Which incentive most effective?**

# Results: Incentive efficiency

- ▶ Results over all 3,100 campaigns



socio-monetary  $>_{st}$  monetary or social

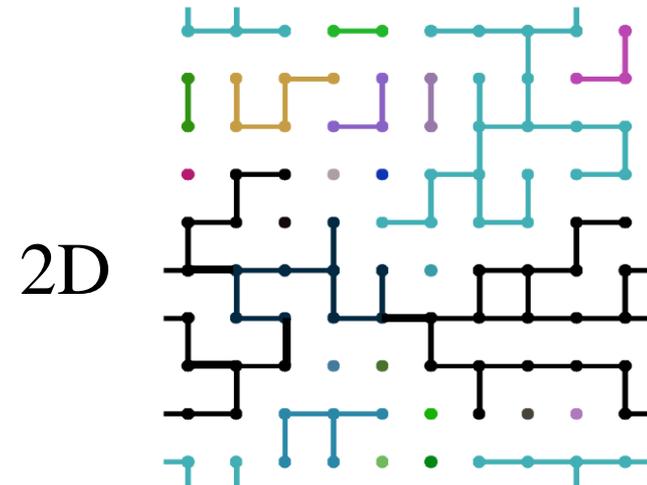
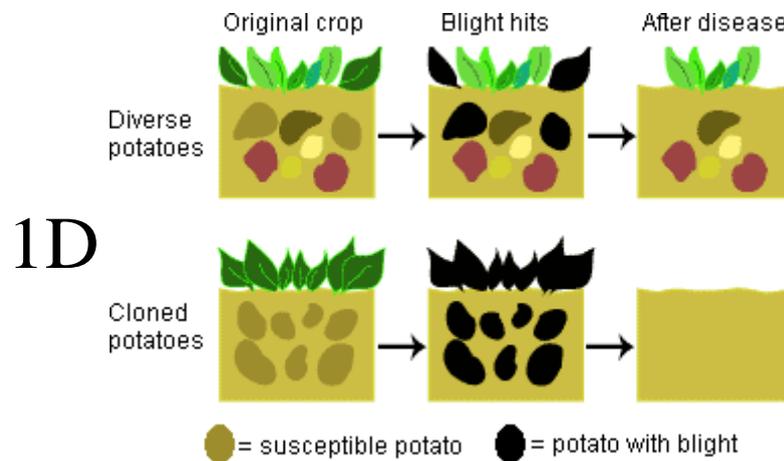
# Socio-monetary ~ monetary?

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self-replicating	✓	✗	✓
mutates to fool defenses	✓	✗	✓
cope with diverse host population	✗	?	✓
	OSN Malware		Biological virus
self-replicating	✗		✓
mutates to fool defenses	✓		
cope with diverse gene pool	?		✓

**Elegant reconciliation of Heyman & Ariely**

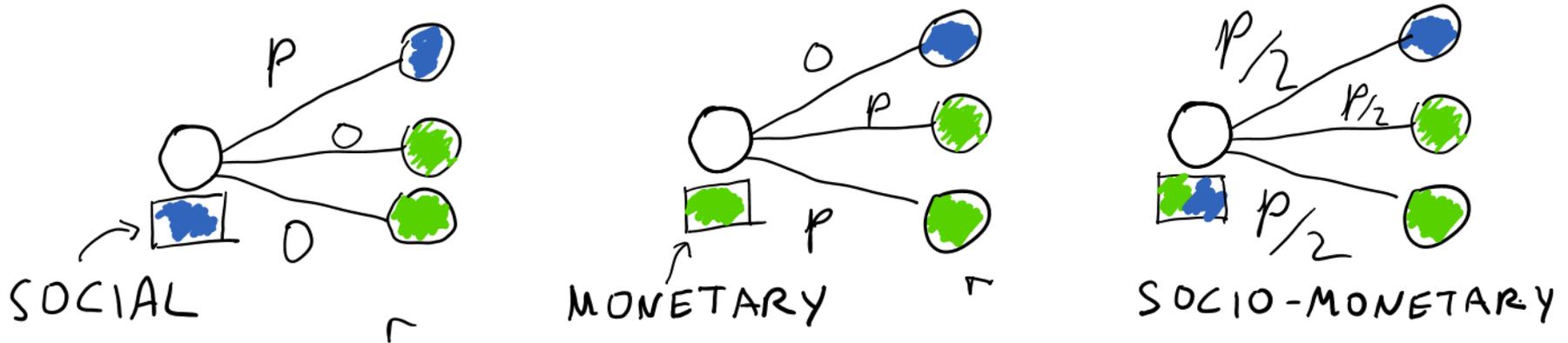
# Mechanics of crop epidemics

- ▶ Resilience of mixed crops

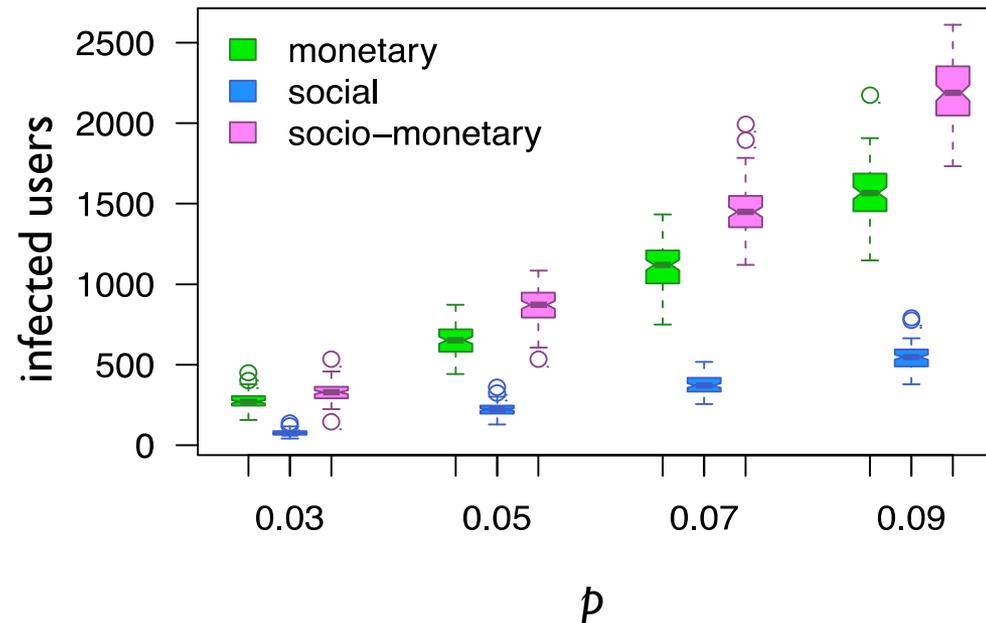


- ▶ Fungi counteracts by becoming flexible (but less virulent) [Chin & Wolfe, 84]
- ▶ Also true for complex systems?

# Epidemics with heterogeneous preferences



- ▶ Enron email network
- ▶ 36,692 nodes
- ▶ Variant of SIR model



# Malware must cope with diversity of incentives

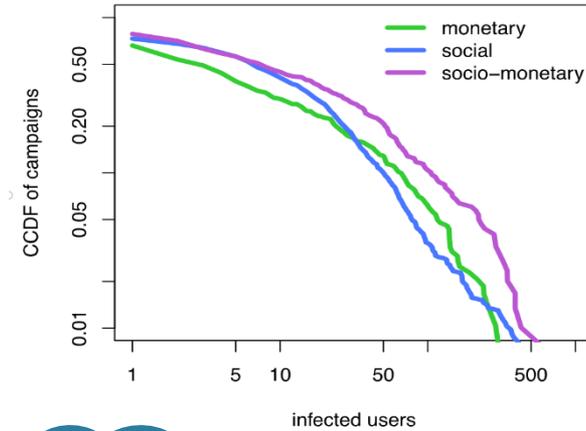
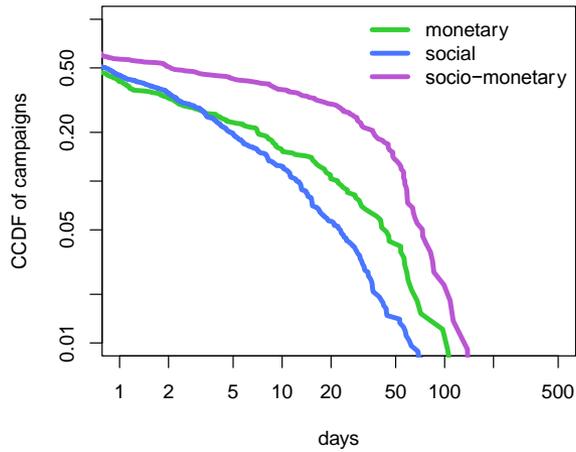
## Completing the picture

	OSN Malware	Biological virus
self-replicating	✘	✓
mutates to fool defenses	✓	✓
cope with diverse “gene” pool	✓	✓

# Conclusions

- ▶ **Labor market incentives** help understand epidemics on online social networks
- ▶ [Heyman & Ariely, 2004] conclusion  
“socio-monetary  $\approx$  monetary” **may not be true in networks due to percolation effects**
- ▶ There can be other explanations  
(**but ours is elegant & fills gap bio  $\leftrightarrow$  techno viruses**)  
*we didn't get university approval for our “malware epidemic” experiment*

# Thank you!



Incentive  
Percolation  
Effects

