

Information spirals in social network dynamics for large Internet databases

YouTube, financial markets, Cyber-risks, Social unrests, Conflicts



Didier Sornette

Chair of Entrepreneurial Risks

ETH Zurich

(Swiss Federal Institute of Technology, Zurich)

Department of Management, Technology and Economics

<http://www.er.ethz.ch/>

Collaborators:

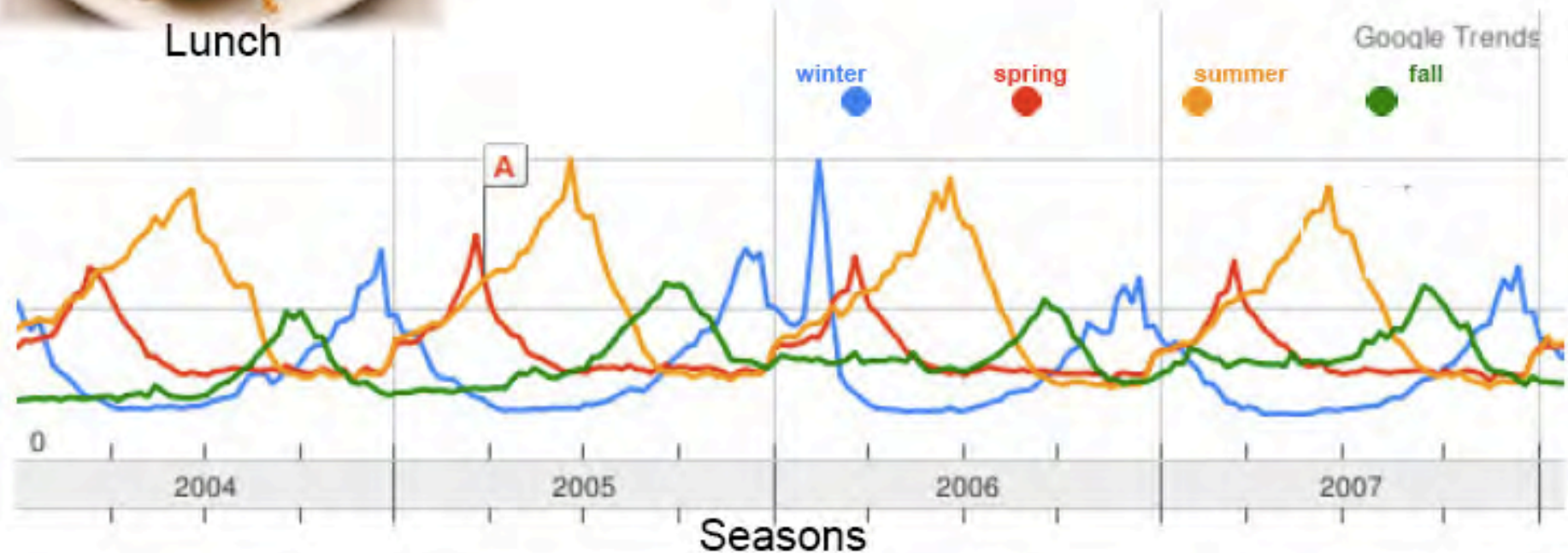
Y. Ageon, J. Andersen, R. Crane, F. Deschatres, T. Gilbert, A. Helmstetter, A. Johansen, N. Johnson, Y. Malevergne, T. Maillart, J.F. Muzy, S. Pillai, B. Roehner

Collective human activity in the time domain



Lunch

Simple trends



Collective human activity

Not so simple trends

Products



Books



Movies



Videos



Collective human activity

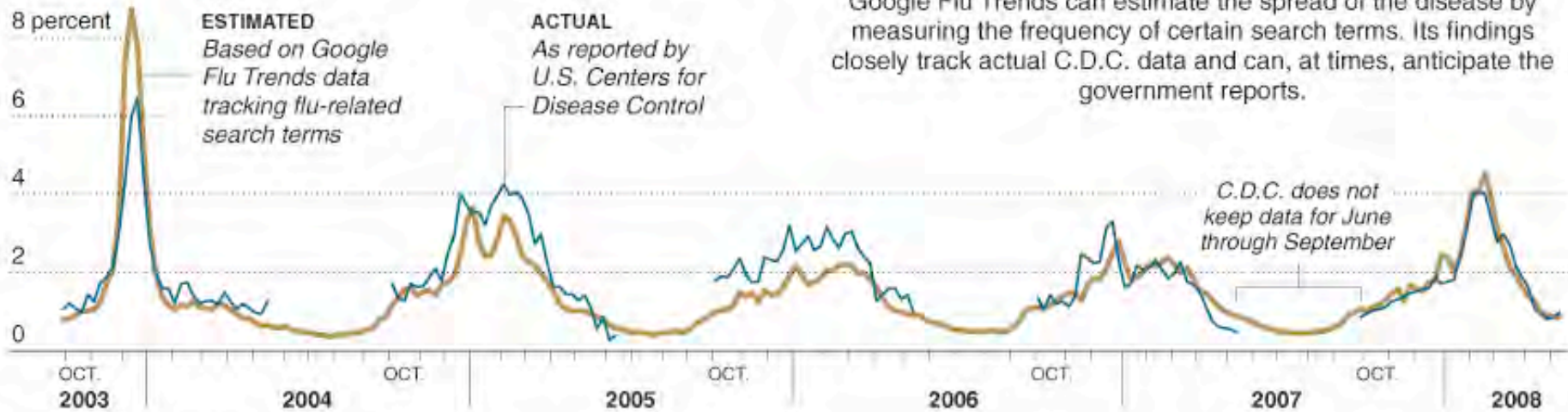
The New York Times

November 12, 2008

PERCENT OF HEALTH VISITS FOR FLU-LIKE SYMPTOMS *Mid-Atlantic region*

Using Google to Monitor the Flu

Google Flu Trends can estimate the spread of the disease by measuring the frequency of certain search terms. Its findings closely track actual C.D.C. data and can, at times, anticipate the government reports.

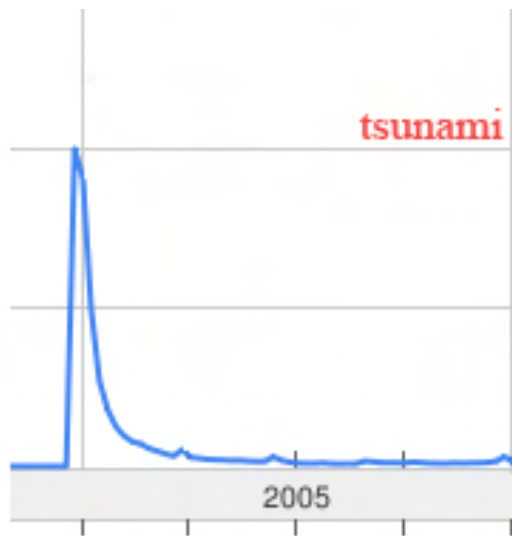


Sources: Google; Centers for Disease Control

THE NEW YORK TIMES

Bursts of activity

Exogenous
event



Endogenous
event



Response function reveals information

The big questions

How do we understand non-trivial herding?

How does the timing of individual activity get modified (renormalized) by interactions?

Model has 2 ingredients:

Timing of individual activity

Epidemic Branching Process

Timing of human activity

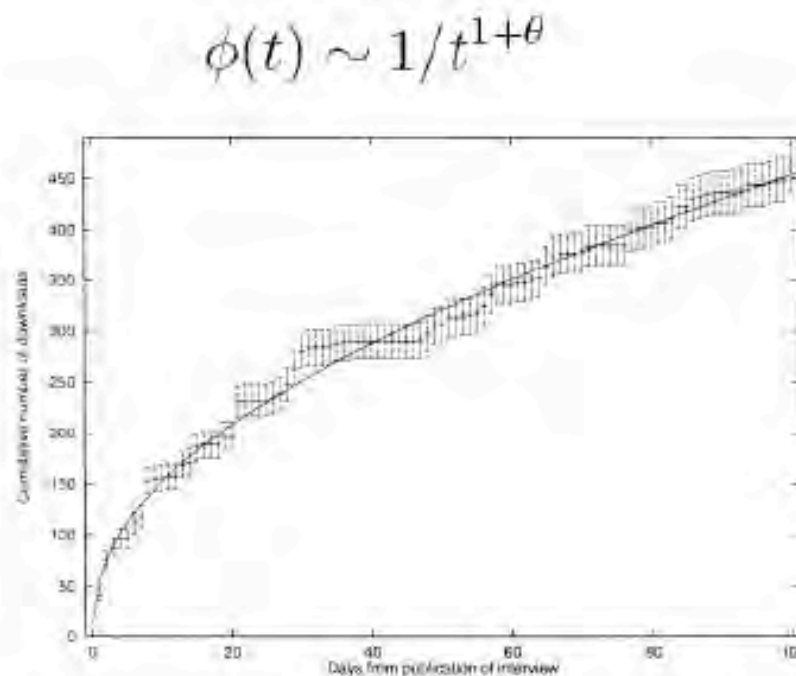
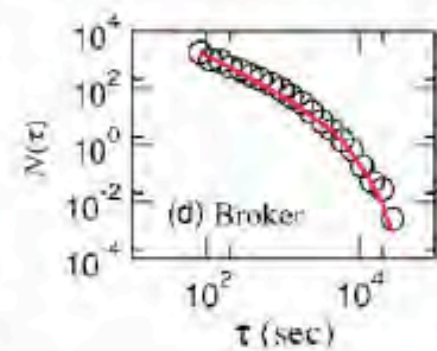
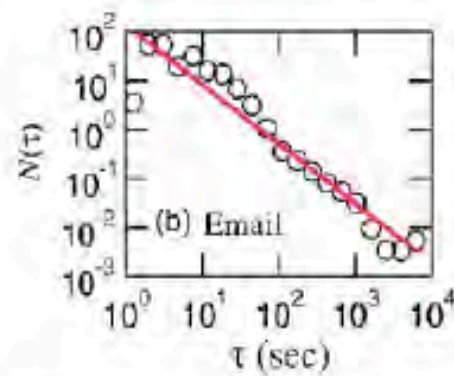
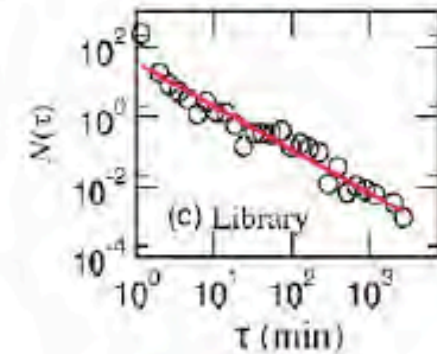
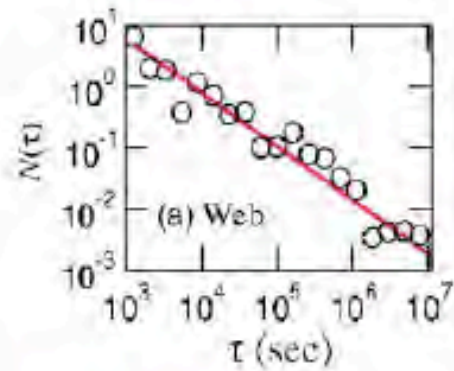


Fig. 1. Cumulative number of downloads N as a function of time t from the appearance of the interview on Wednesday the 14 April 1999. The fit is $N(t) = [a(1 - \phi)t]^{-1/\theta} + c$ with $\phi \approx 0.58$.

Somette & Johansen, Physica A 276, 338 (2000)



Vazquez, Oliveira, Dezo, Goh, Kondor, Barabasi, PRE 73, 036127 (2006)



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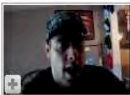


Deat Body.., Got Halo 3?, Worcester Love Epis..., Woody's sneak peak

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Final Words... Thank you YouTube!

This is it guys...

From: desjaince766 Views: 22,069

Time: 03:30

More in People & Blogs



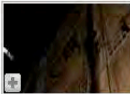
The Cacaman - Ain't Got Much of ...

The Cacaman's Music Video for "Ain't got much of a smile." Original music and Lyrics by The Cacaman. Check out more at: http://

From: CacamanMusic Views: 143,521

Time: 03:42

More in Music



Rescue children living in povert...

I believe children, no matter where they are born, deserve to live free of danger, abuse and poverty. I Stir for a better world! (more)

From: WorldVisionStr Views: 51,614

Time: 01:21

More in News & Politics



Ezekiel's Story

The Taylors shared their baby story, now go tell yours by visiting www.marchofdimes.com/everybaby Following the premature birth (more)

From: MarchofDimes Views: 36,002

Time: 06:31

More in People & Blogs



Share Your Story at the 92nd Str...

Sharing Stories about the 92nd Street Y in New York City. To learn more about the 92nd Street Y, visit http://www.92Y.org

From: 92ndStreetY Views: 18,122

Time: 03:08

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MOTORAZR2 ESSENCE OF SHARPER TRAILER

From: MOTORAZR2 Comments: 0

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What's New

YouTube Nonprofit Program Broadcast your cause! Apply for the Nonprofit program and use video to get your organization's message out.

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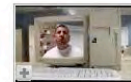
Create Custom Players Now you can choose the design and color of your player, and fill it with any of your playlists!

Broadcast Your Cause: The YouTube Nonprofit Program

Does your nonprofit organization have a great story to tell? Do you want to connect with supporters online but don't have the money for expensive outreach campaigns? Or are you just looking for way...

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The Front Page



Open Your Eyes - Sean Delaney Sean Delaney is musician as well as a Direct Support Professional with the Special Needs Program in upstate New York. After spendi (more)

From: AutismSpeaksVids Views: 52,531

Time: 03:48

More in Music



WOMEN OF DARFUR

IRC communications officer Emily Holland recently traveled to Darfur to document the lives of displaced Sudanese. In this video, (more)

From: theirc Views: 84,468

Time: 01:22

More in News & Politics



Polar Bears

Two polar bears muse on the causes of global warming. An entry for our green film competition. http://www.foe.co.uk for info.

From: friendsoftheearth Views: 235,760

Time: 01:00

More in Film & Animation



E-Waste: Dumping on the Poor ??

Asia Society's multimedia look at electronic waste shipped overseas and the toxic effect it has on places such as Guiyu, China--kn (more)

From: asiasociety Views: 102,646

Time: 04:35

More in News & Politics



24 Hours for Darfur -- Numbers &...

This video montage highlights people's efforts to grapple with the scope and depth of violence and suffering wrought by the genoc (more)

From: 24hoursfordarfur Views: 21,139

Time: 04:05

More in News & Politics



Kanye West: Education needs to b...

http://www.edin08.com - Join Kanye and ED in '08 ED in '08 is a campaign to make America's schools a top issue in the 2008 pres (more)

From: Edin08 Views: 241,230

Time: 00:29

More in News & Politics



Contest to End Youth Homelessness

A video explanation of the "Out Of The Shadows" Contest to end Youth Homelessness. Find out what you can do to address the problem (more)

From: YouthNoise Views: 52,505

Time: 01:30

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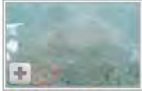

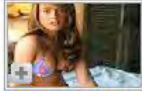



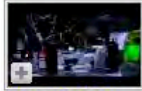
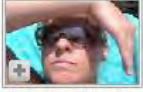




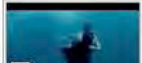


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Unwetter Slowenien
01:24
Added: 25 minutes ago
From: [willem1946](#)
Views: 1

Interview du créateur de Heroes
08:19
Added: 25 minutes ago
From: [Dewey63](#)
Views: 0

un tanar batut de politie
00:23
Added: 25 minutes ago
From: [mcmadrid](#)
Views: 0

Joey Bean Walking 3
00:35
Added: 25 minutes ago
From: [happyheatherly](#)
Views: 0

beautiful lady
03:01
Added: 25 minutes ago
From: [shvgal34](#)
Views: 1

thyra
01:03
Added: 25 minutes ago
From: [ruffiBITCH](#)
Views: 2

Halo 2 Artillery Bombardment
00:36
Added: 25 minutes ago
From: [bondboy8](#)
Views: 0

Se7en on STAR real story I AM [Ariang TV 4-7-2007] Part 5
05:00
Added: 25 minutes ago
From: [AkaKelvin](#)
Views: 0

"When you walk by" - Live Song @ wedding (HEBREW)
05:15
Added: 25 minutes ago
From: [eshedesh](#)
Views: 0

Re: Eric and the Army of the Phoenix (1/5)
09:59
Added: 25 minutes ago
From: [ximubayu](#)
Views: 0

Ida Di Benedetto Light up cigarette
00:14
Added: 25 minutes ago
From: [MDL72](#)
Views: 0

hczvole
03:11
Added: 25 minutes ago
From: [Hodnak](#)
Views: 0

jealous guy
09:59
Added: 25 minutes ago
From: [bigbreadeaterellis](#)
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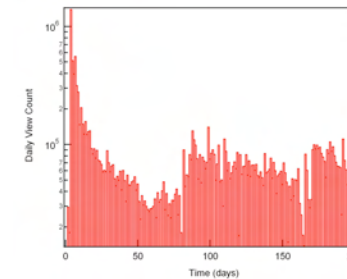
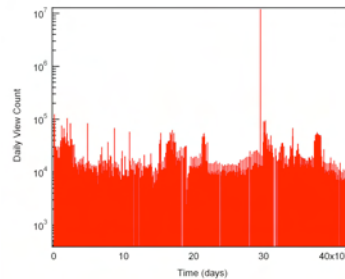
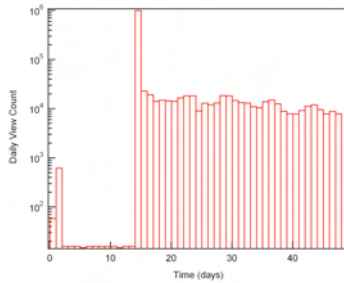
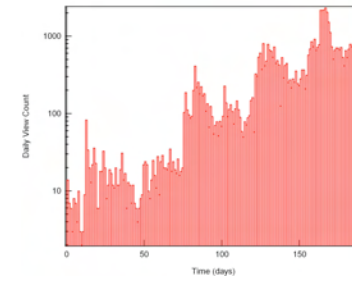
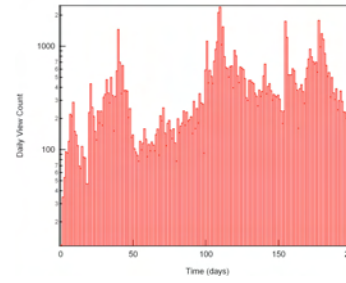
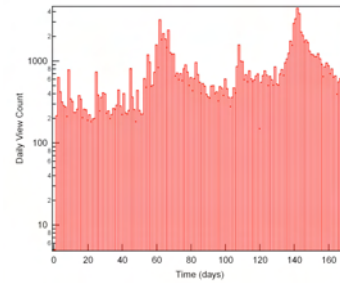
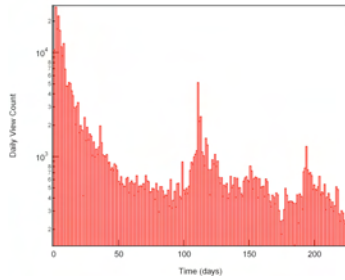
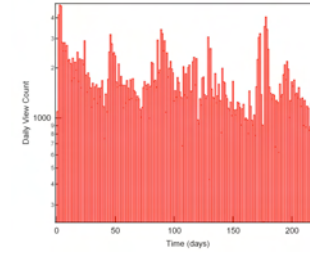
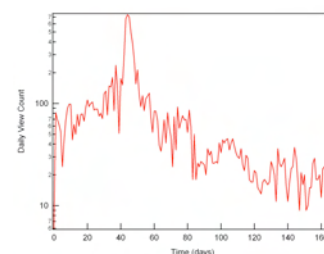
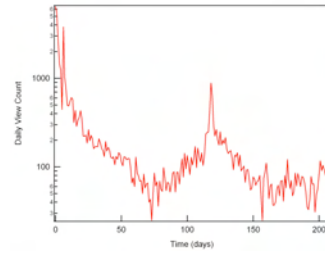
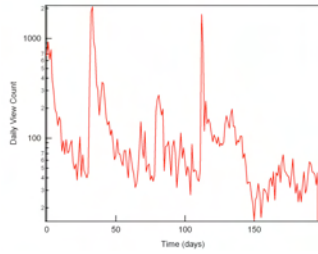
im a sucker
03:12
Added: 25 minutes ago
From: [alexcityhero](#)
Views: 1

9-6 Friends Forever 2004-07
08:16
Added: 25 minutes ago
From: [shbita92](#)
Views: 0

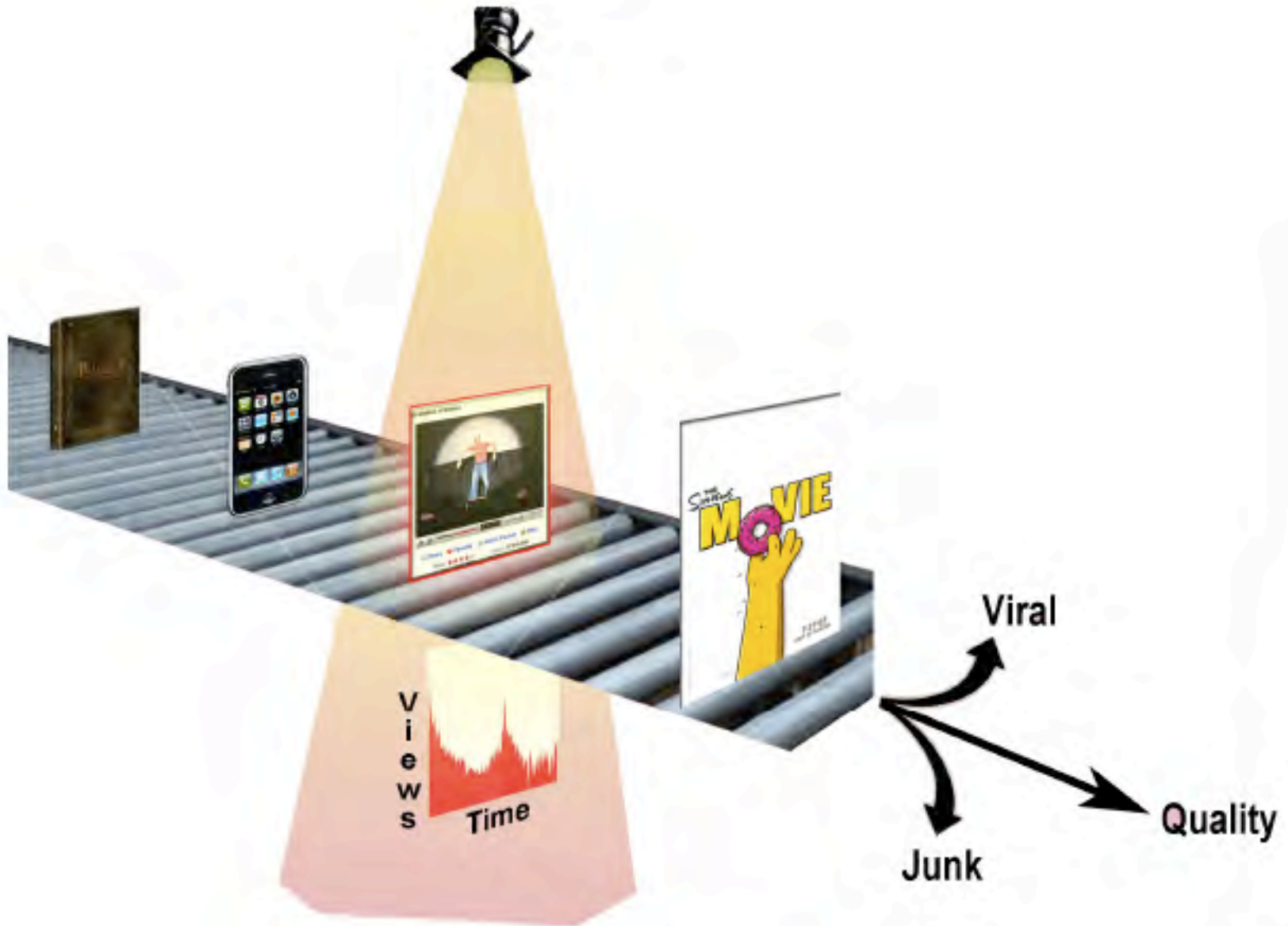
CONTINUED, SMOKING:MAGNUM PIPE TOBACCOS.
03:13
Added: 25 minutes ago
From: [MARIANUSPIPESTOBACCO](#)
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Lots of interesting dynamics

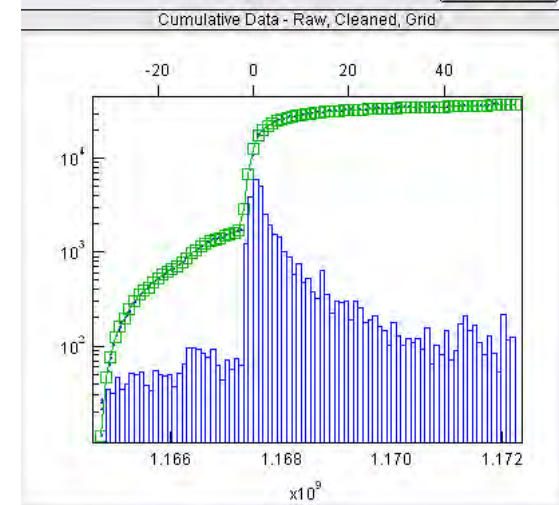
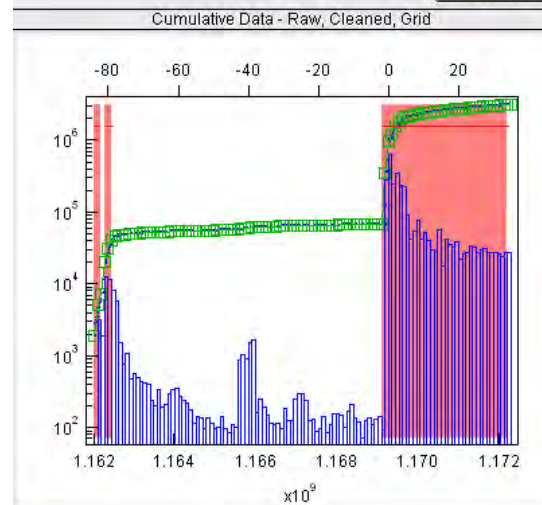
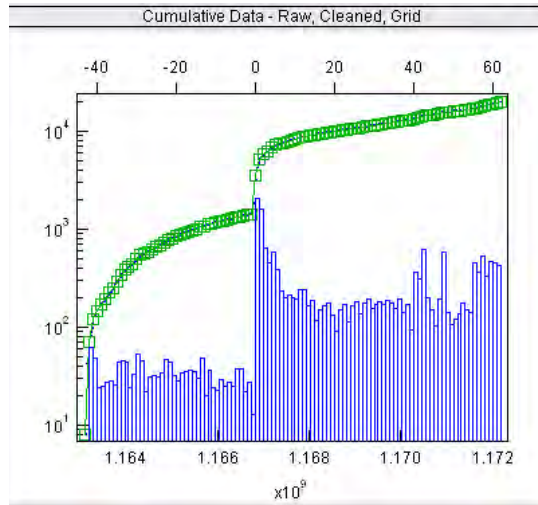


Study of the time dynamics

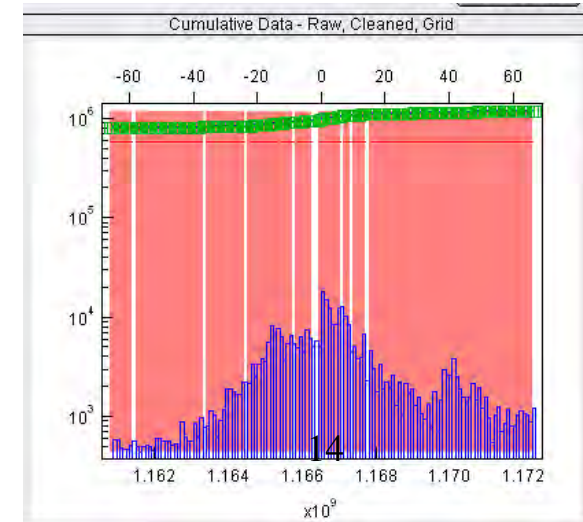
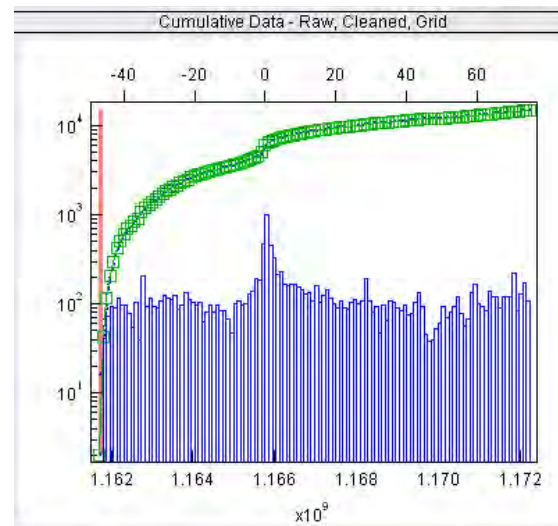
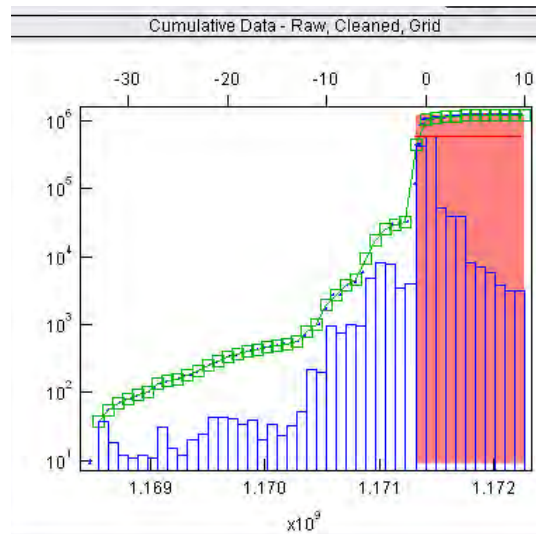


YouTube viewer dynamics

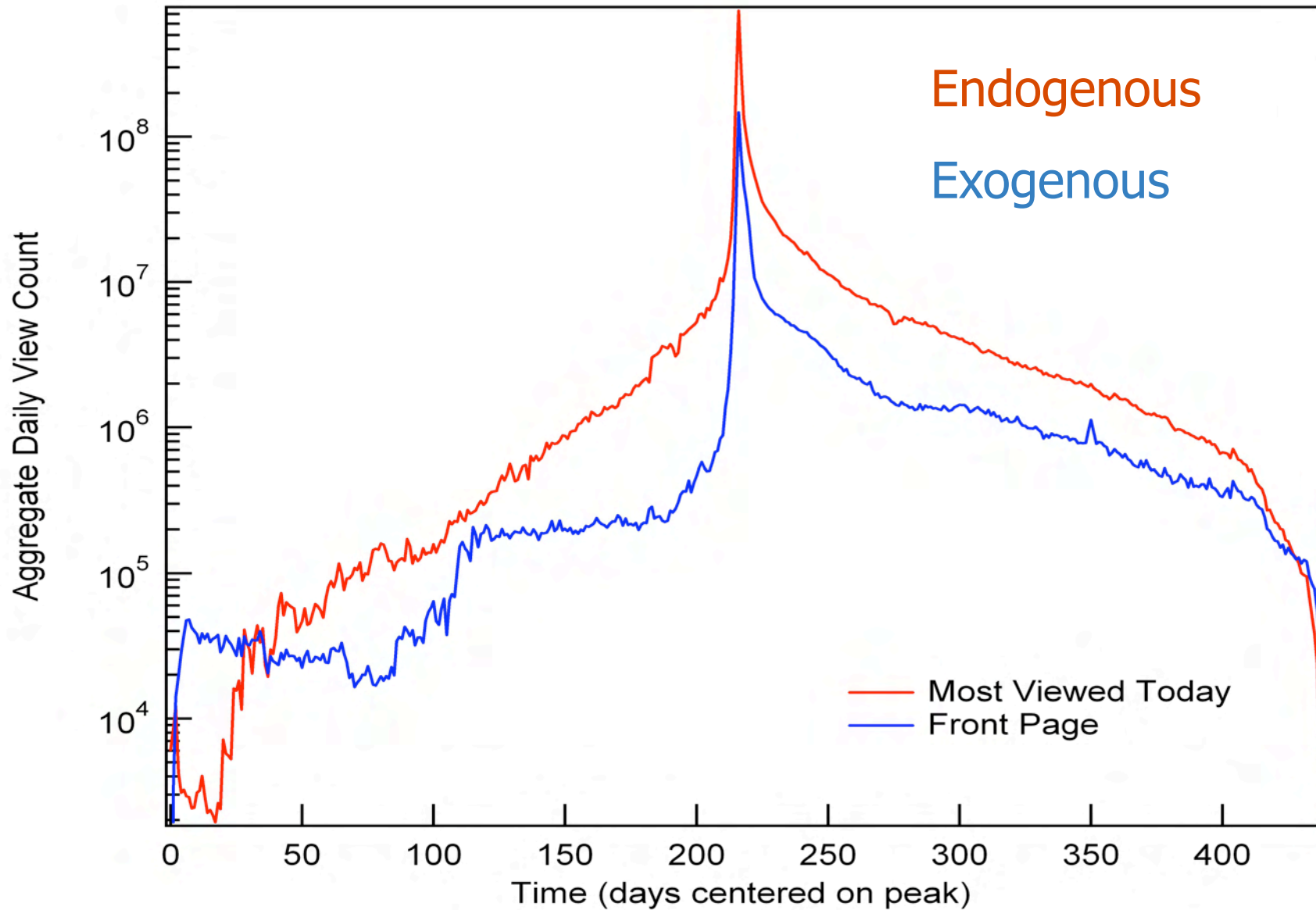
Exogenous



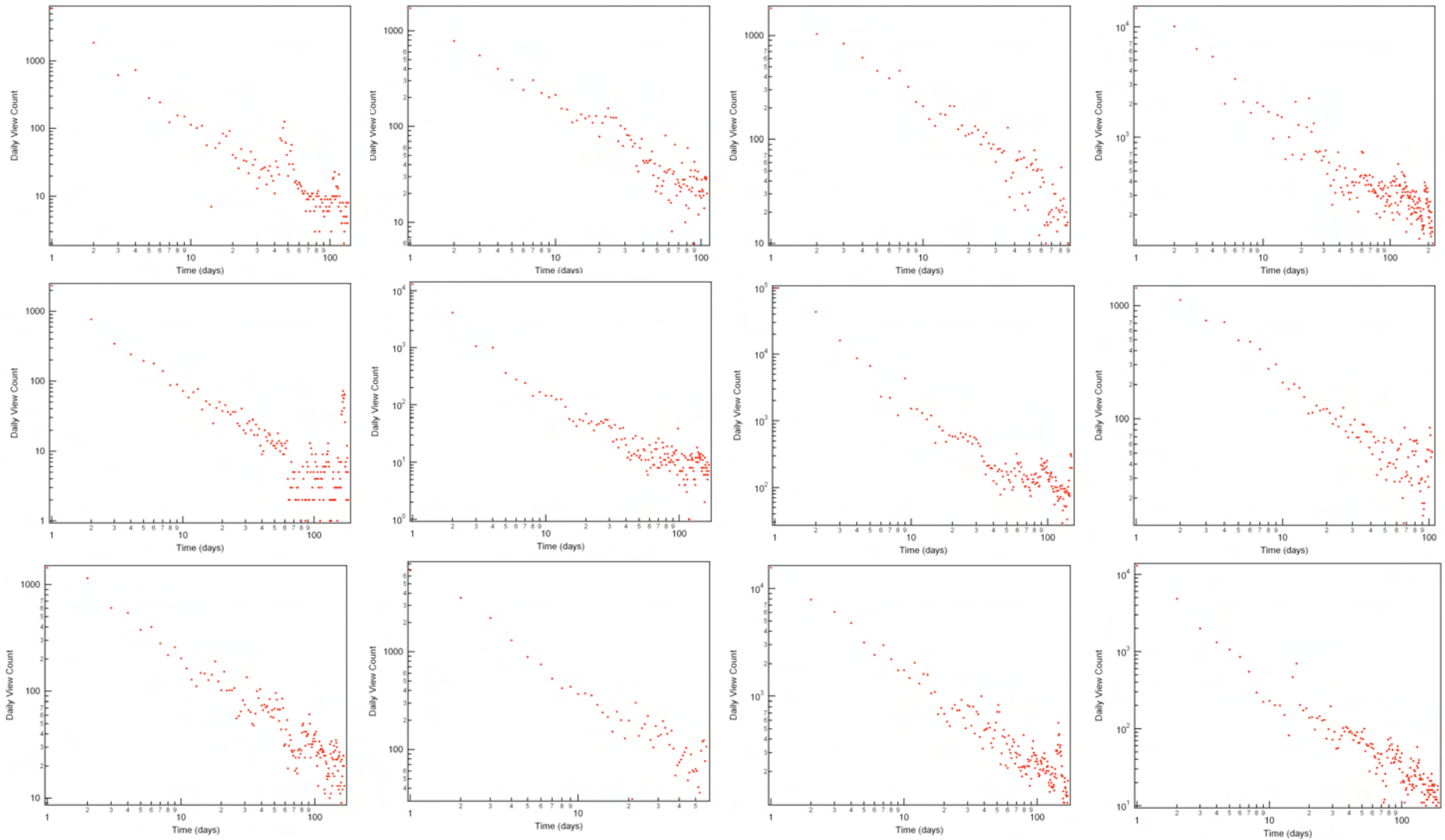
Endogenous



Non-Parametric Superposition



Typical Relaxation Following Peak



How to explain these dynamics?

- pdf of waiting times between cause and action and rate of activity

$$P(\tau) \sim \frac{1}{\tau^{1+\theta}} \quad \text{with } \theta \geq 0$$

- Priori-queuing (Abate & Whitt, 1997)
 - Time-varying activity rate with feedback (Vasquez, 2007)
 - Random walk crossing condition
-
- Epidemic cascades in social networks

- pdf of waiting times between cause and action and rate of activity



$$P(\tau) \sim \frac{1}{\tau^{1+\theta}} \quad \text{with } \theta \geq 0$$

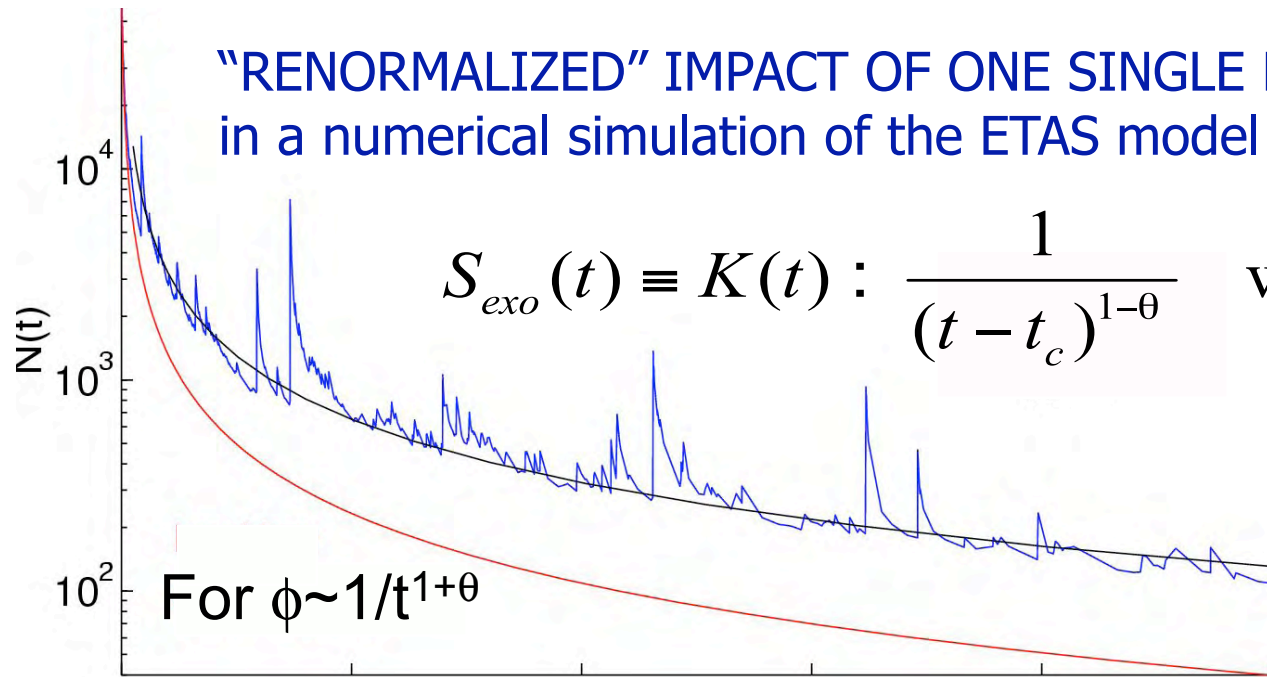
Epidemic processes by word-of-mouth



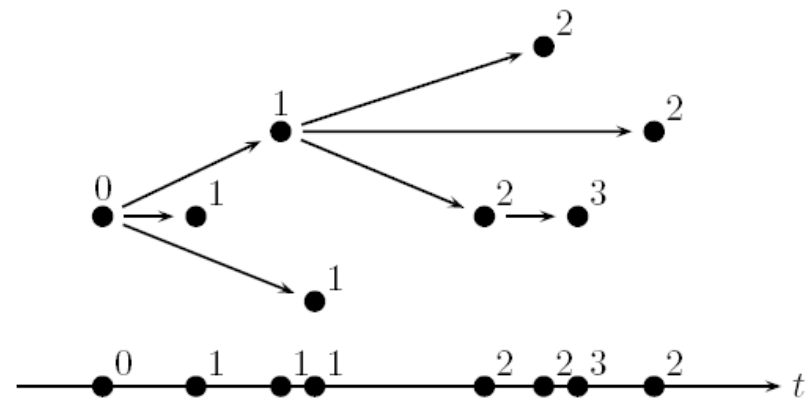
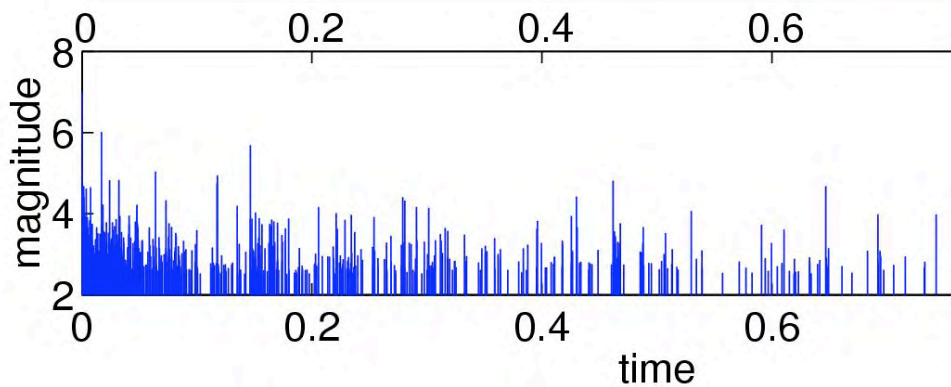
Hawkes ETAS model and numerical simulations

The impact of cascades of generations

“RENORMALIZED” IMPACT OF ONE SINGLE PIECE OF INFORMATION
in a numerical simulation of the ETAS model



$$S_{exo}(t) \equiv K(t) : \frac{1}{(t - t_c)^{1-\theta}} \quad \text{with } 0 < \theta < 1$$



Predictions of the model

sub-critical

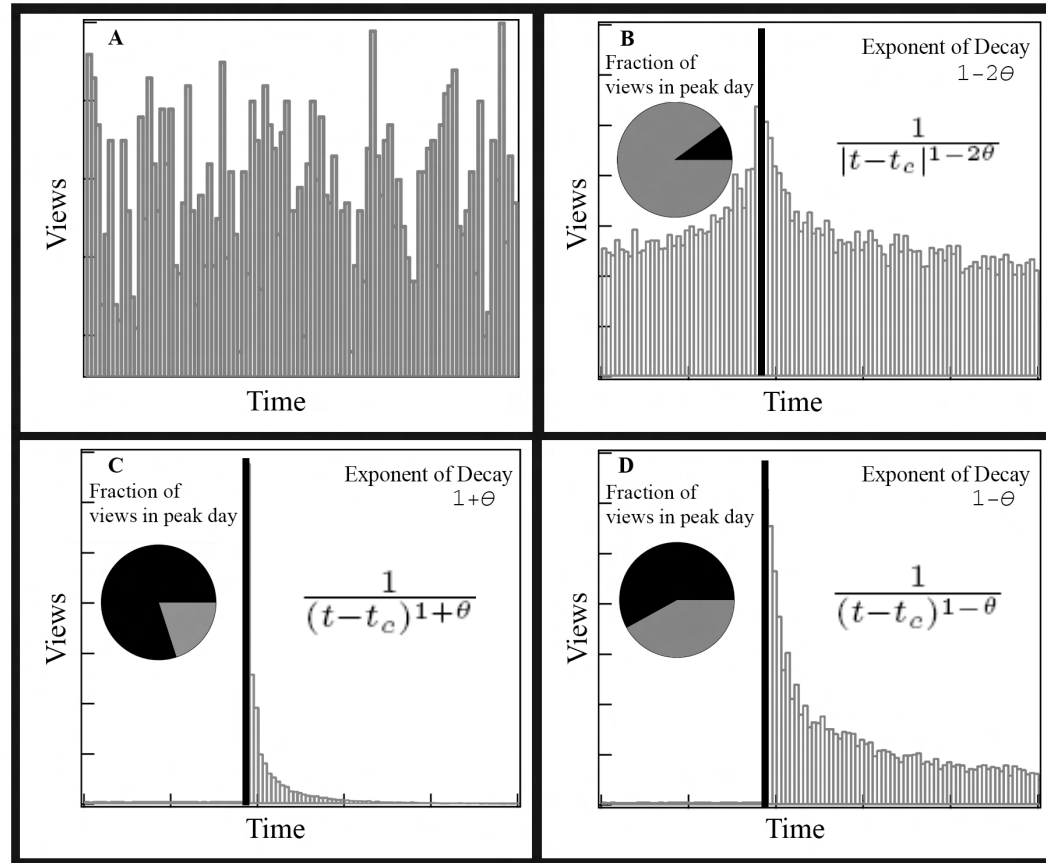
critical

Sub - Critical

Critical

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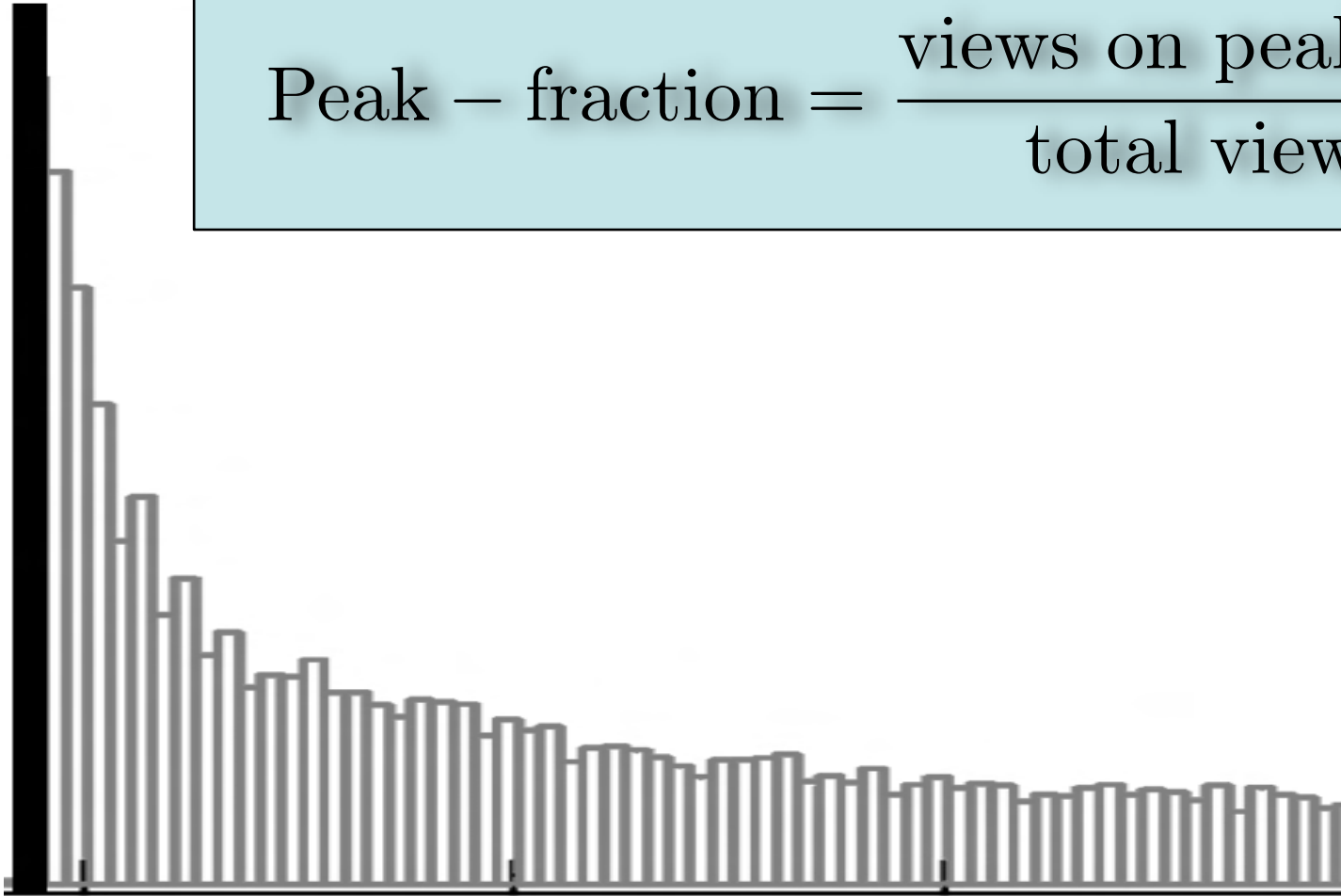


EXO

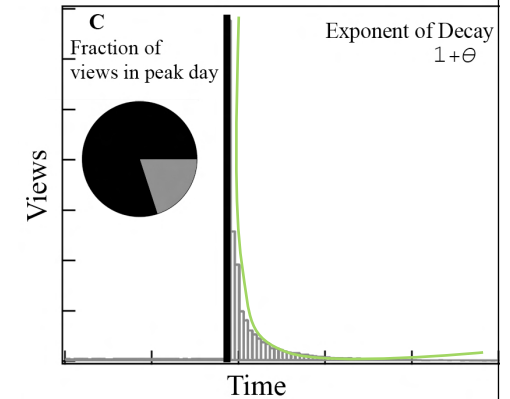
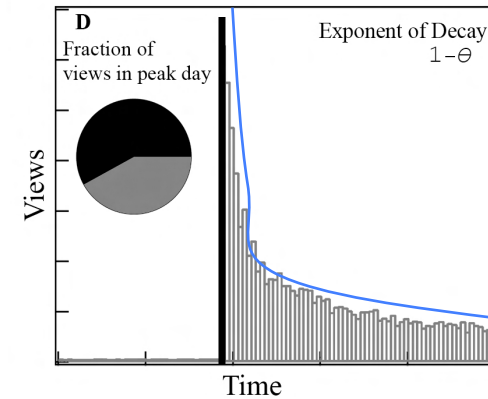
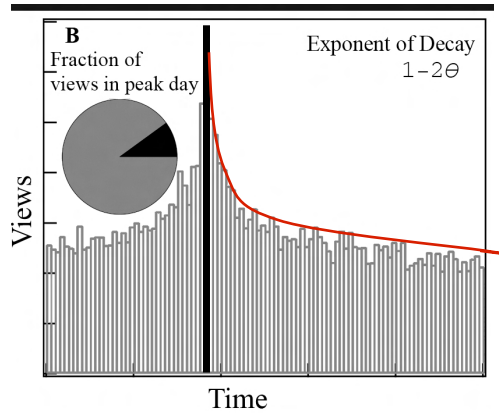
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Sort data, look at exponents

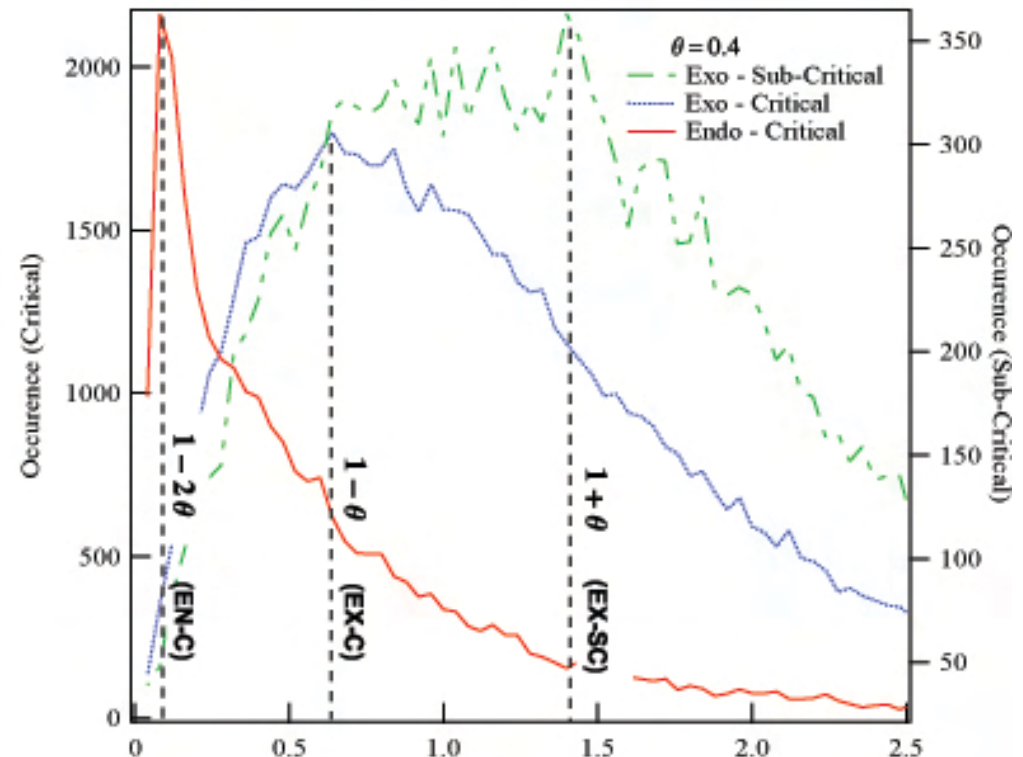
$$\text{Peak - fraction} = \frac{\text{views on peak day}}{\text{total views}}$$



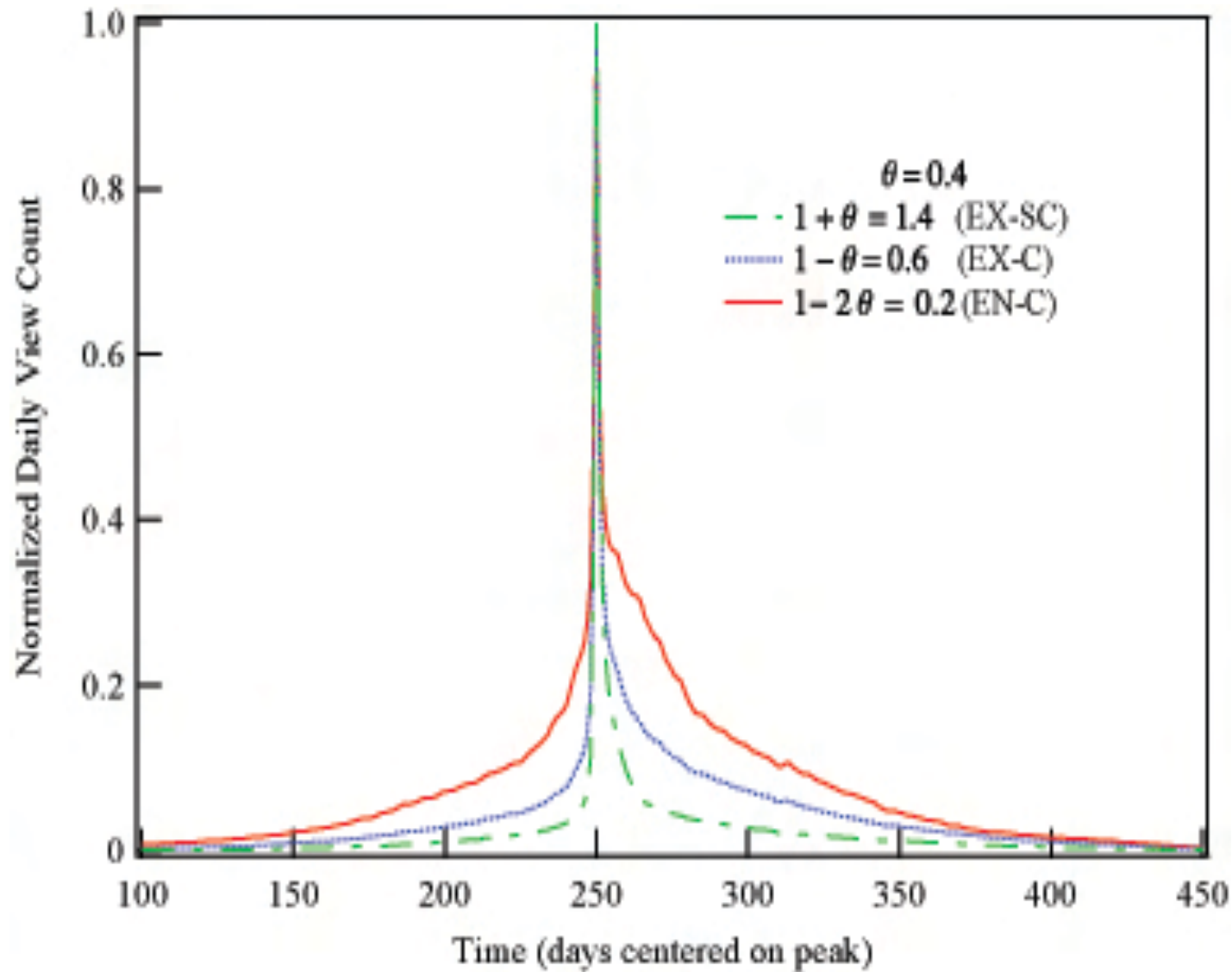
Distribution of relaxation exponents



1. Class 1 is defined by $80\% \leq F \leq 100\%$.
2. Class 2 is defined by $20\% < F < 80\%$.
3. Class 3 is defined by $0\% \leq F \leq 20\%$.



What about precursory information?

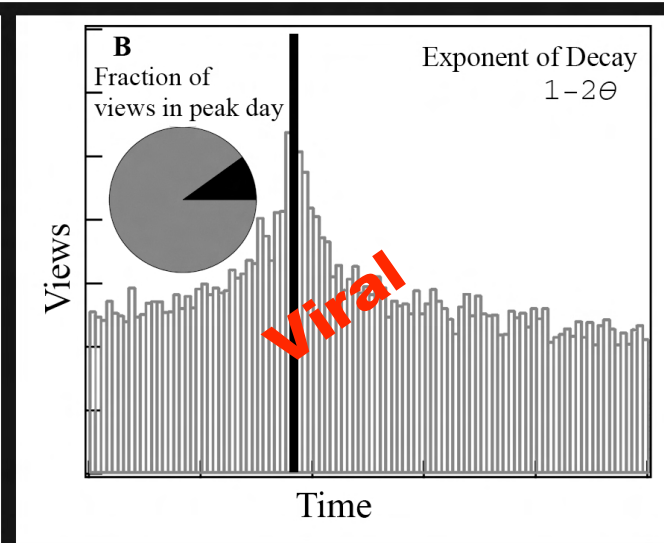
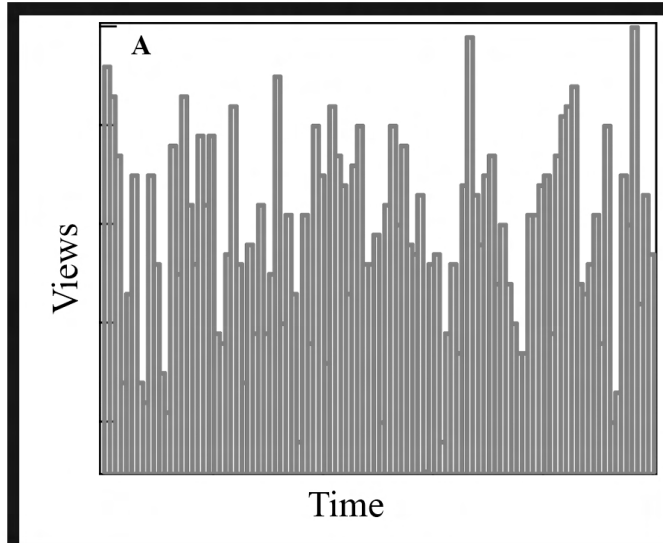


Qualitative classifications

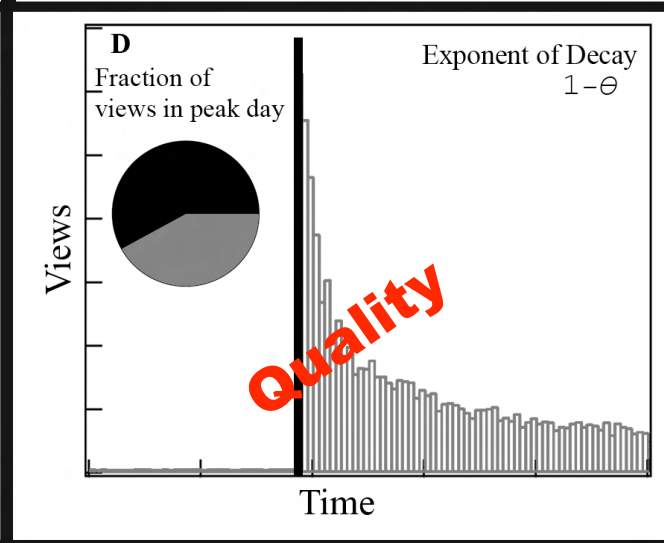
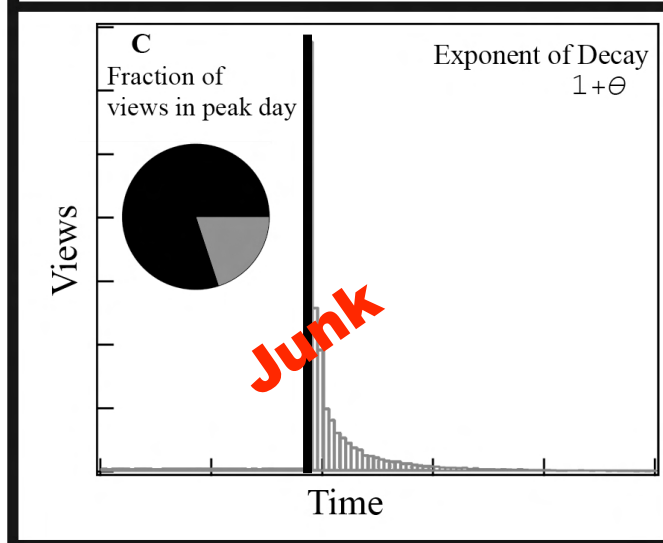
Sub - Critical

Critical

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Many other applications

- Book, CD music sales...
- Internet searches
- Open source software projects
- Ethical Hacking security
- NATO (National Association of Theatre Owners)
- Recommendation Blogs

AMAZON BOOK SALES

- Amazon.com posts a “live” ranking of all its products
- Book ranks in the top 10,000 are updated **every hour** according to a secret weighting of recent sales and entire history

Top 100 Bestsellers

Updated Hourly



1. [The South Beach Diet](#)

by Arthur Agatston
(Author)

Price: \$14.97 You Save:
\$9.98 (40%) [Used & new](#)
from **\$13.24**



2. [The Da Vinci Code](#)

by Dan Brown (Author)

Price: \$14.97 You Save:
\$9.98 (40%) [Used & new](#)
from **\$10.80**



3. [The Last Juror](#)

by John Grisham (Author)

Price: \$19.57 You Save:
\$8.38 (30%)



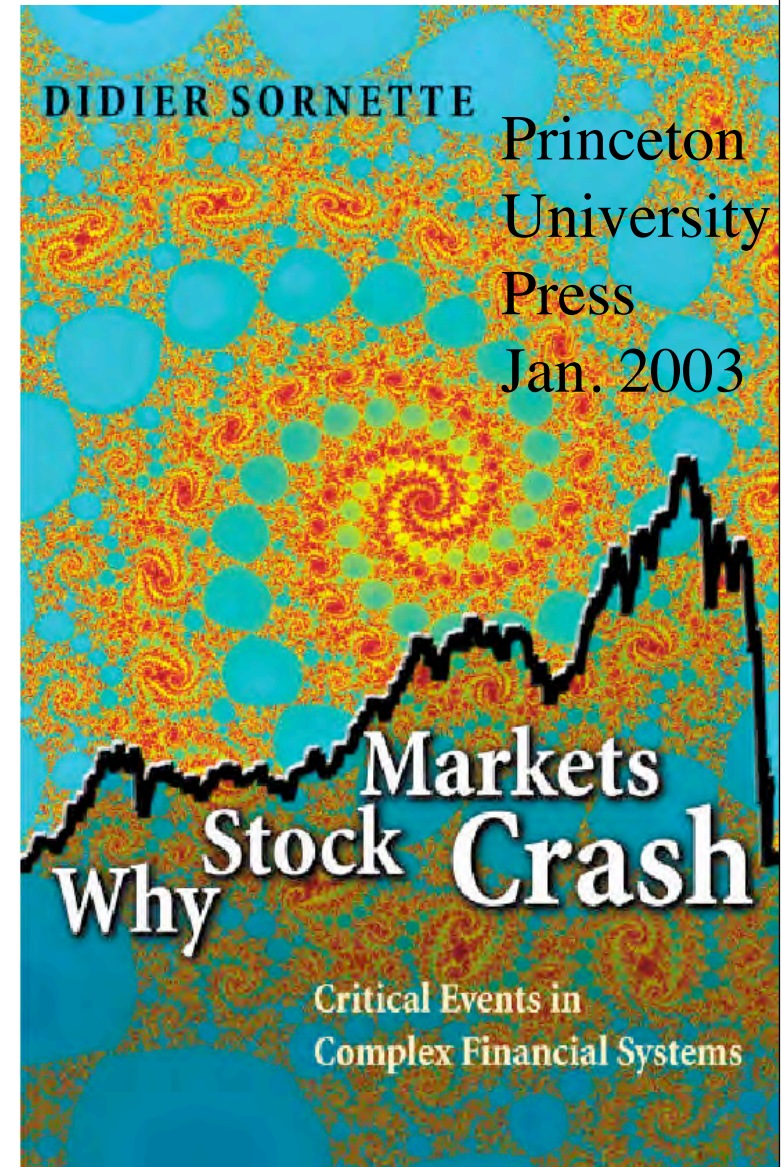
4. [South Beach Diet Good Fats/Good Carbs Guide](#)

by Arthur Agatston
(Author)

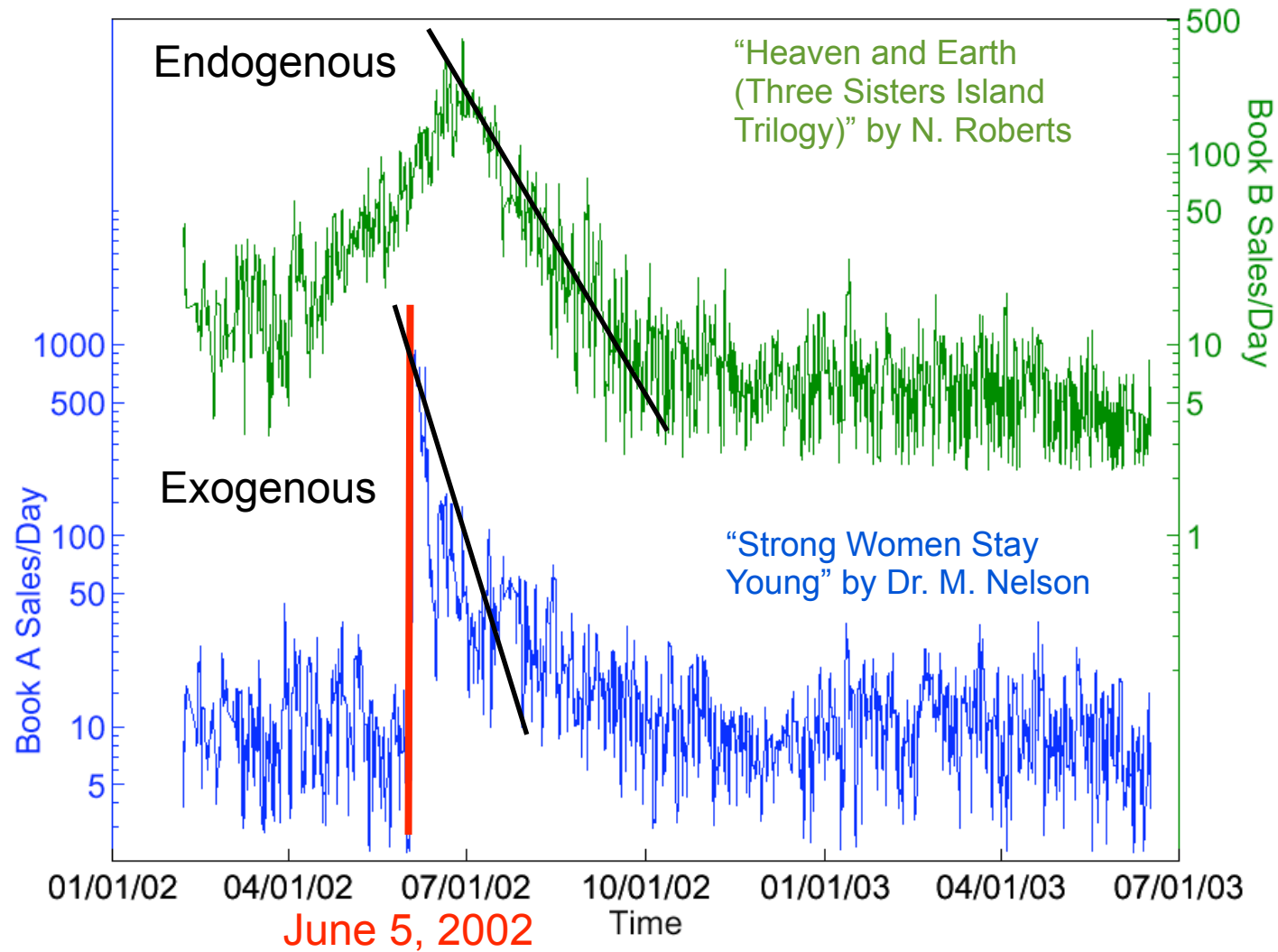
Price: \$7.99 [Used & new](#)
from **\$7.80**

The Original “Crisis”

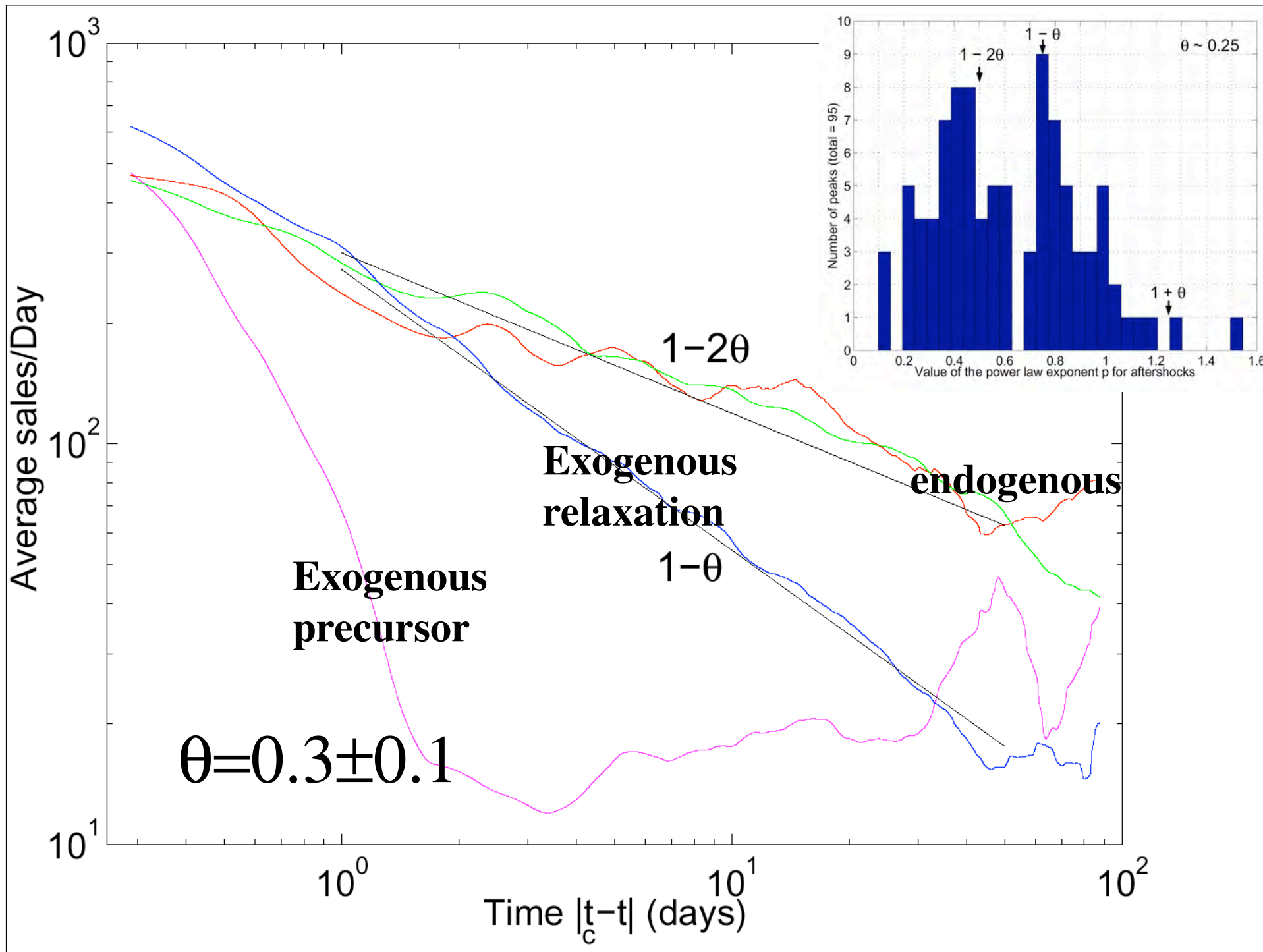
- On Friday January 17, 2003, Sornette’s recent book jumped to rank # 5 on Amazon.com’s sales ranking (with Harry Potter as #1!!!)
- Two days before: release of an interview on MSNBC’s MoneyCentral website



Book sales dynamics



June 4, 2002:
New York Times article crediting the "groundbreaking research" of Dr. Nelson



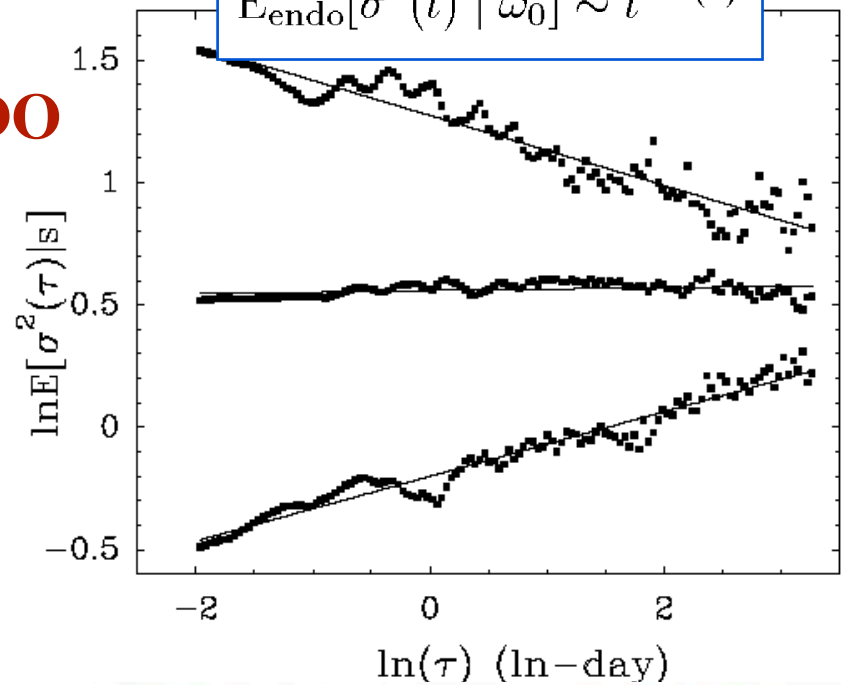
Empirical Implications

- If buys were mainly initiated via news and advertisements, the model predicts an exponent of $1+\theta$
- So the power-law exponents being smaller than 1 indicates:
 - Sales dynamics is dominated by **cascades** involving high-order generations
 - This implies that $n \sim 1$, i.e. **the social network is close to critical**
- Identification of critical niches for optimal marketing strategy

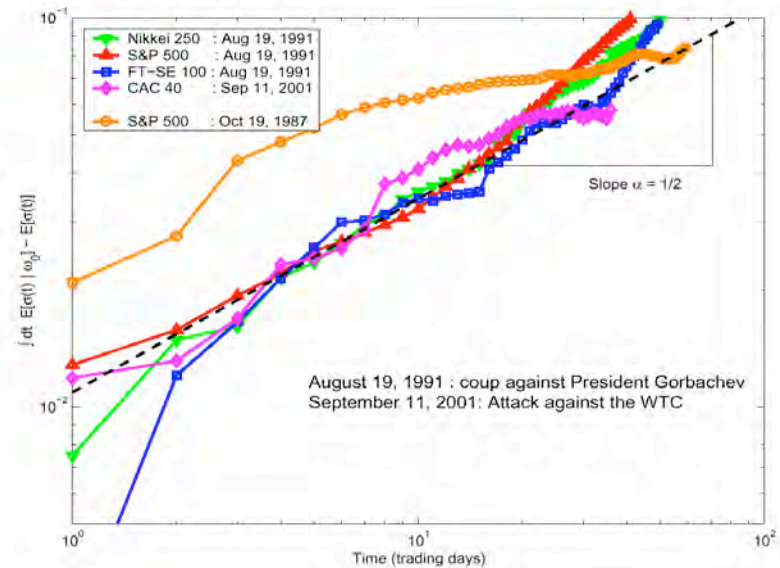
Financial volatility foreshocks and aftershocks

ENDO

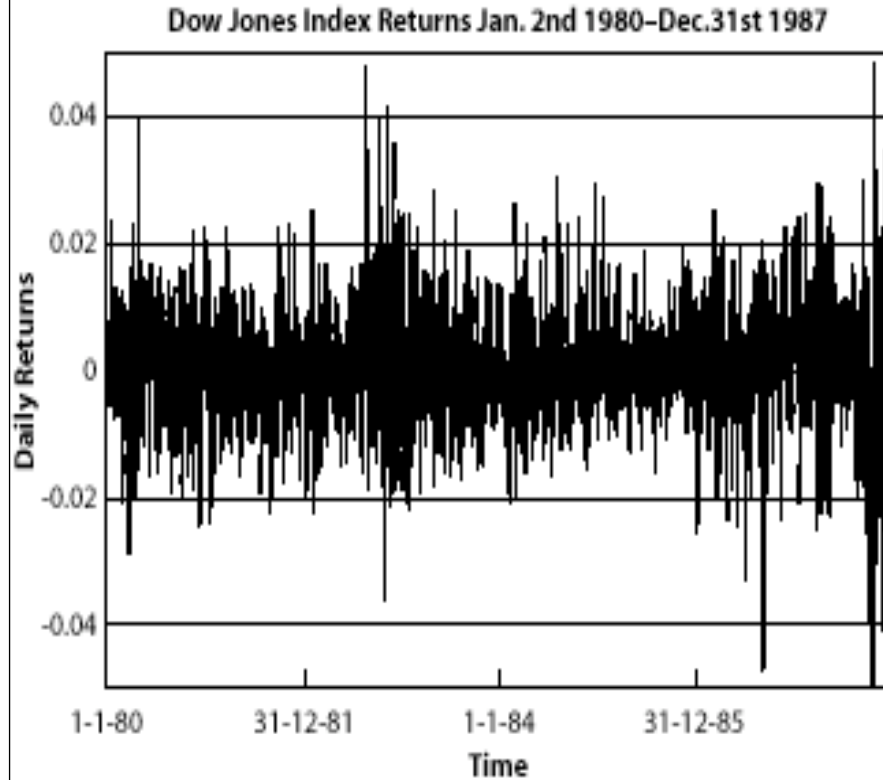
$$E_{\text{endo}}[\sigma^2(t) | \omega_0] \sim t^{-\alpha(s)}$$



EXO



$$E_{\text{exo}}[\sigma^2(t) | \omega_0] - \overline{\sigma^2(t)} \propto e^{2K_0 t^{-1/2}} - 1 \approx \frac{2K_0}{\sqrt{t}}$$



Economics of Cyber Crime

- vulnerabilities / patches dynamics
 - core problem leading to economic arbitrage...
 - ...deeply in favor of crime !
- there is no strong business incentive to make secure software (people are happy already when software works properly!
- complexity of IT systems prevent fast

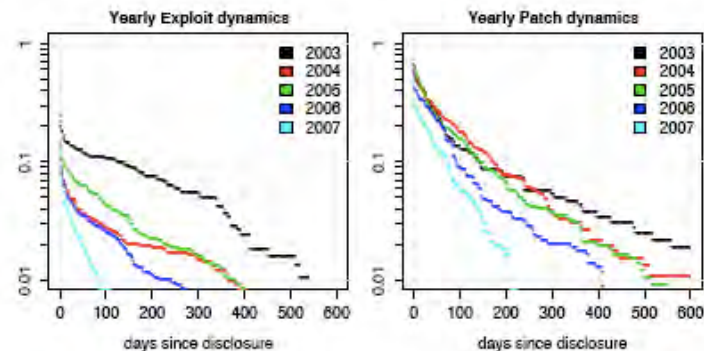
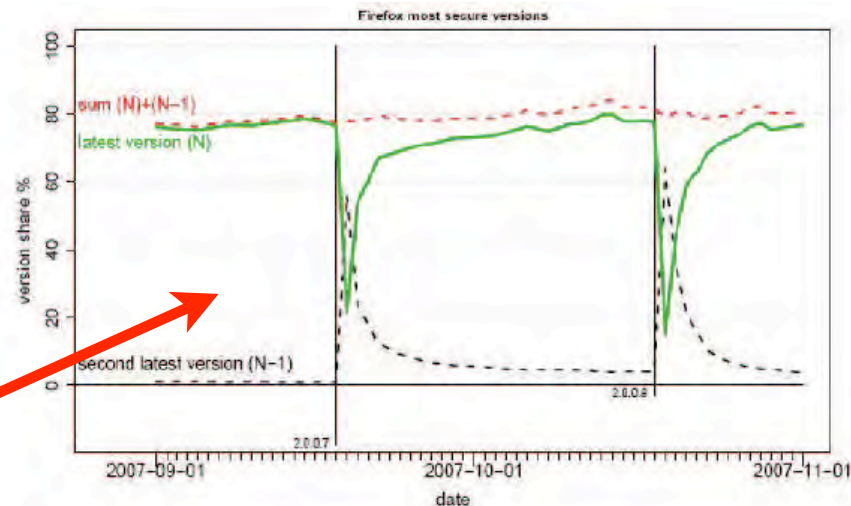


Figure 5.14: Evolution of yearly exploit and patch availability 2003 to 2007.

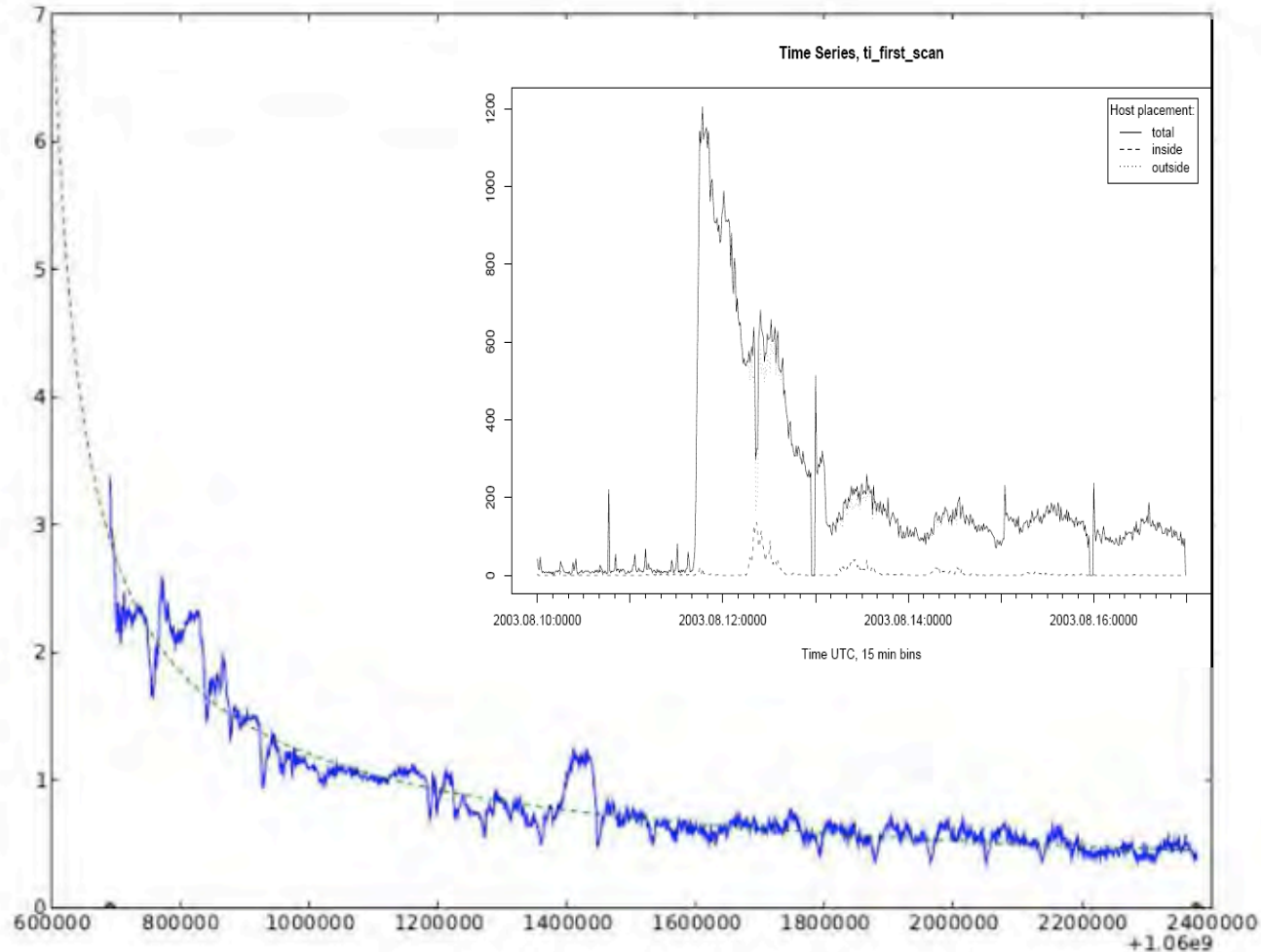
with Stefan Frei, TIK ETH Zürich



with Google Switzerland

FIG. 2: This figure shows the decay in proportion of installed browsers of an old version ($N - 1$) after a new minor release

Cyber-risks: worms never disappear...



Power-law fit to the decay of the rate of active infections after removing seasonality, following the outbreak of the blaster virus on the Swiss SWITCH network, as a function of time from 2003 to 2008.

Application to conflict early warning

with P. Meier (Tufts Univ., Boston) and R. Woodard (ETH Zurich)

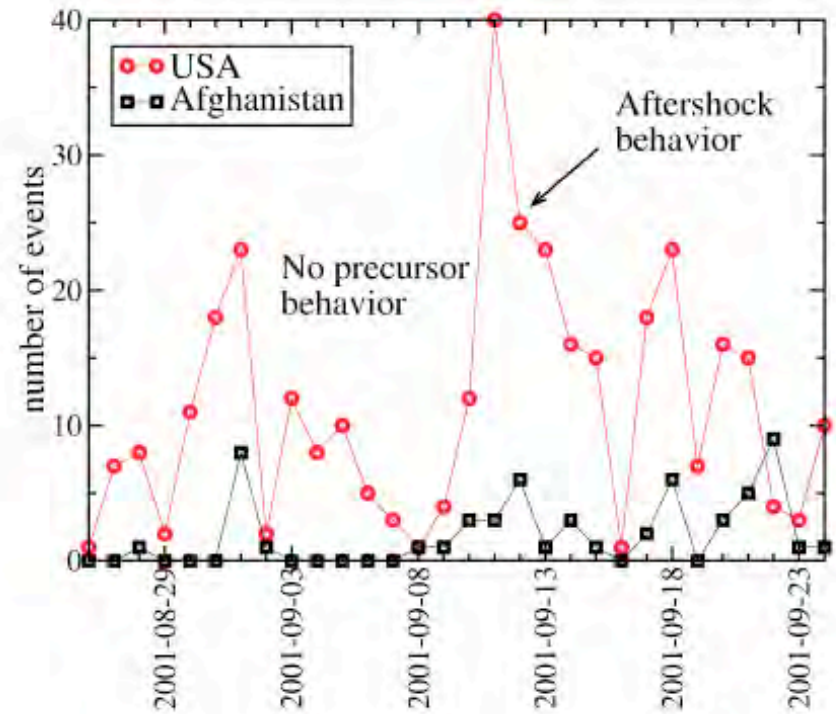
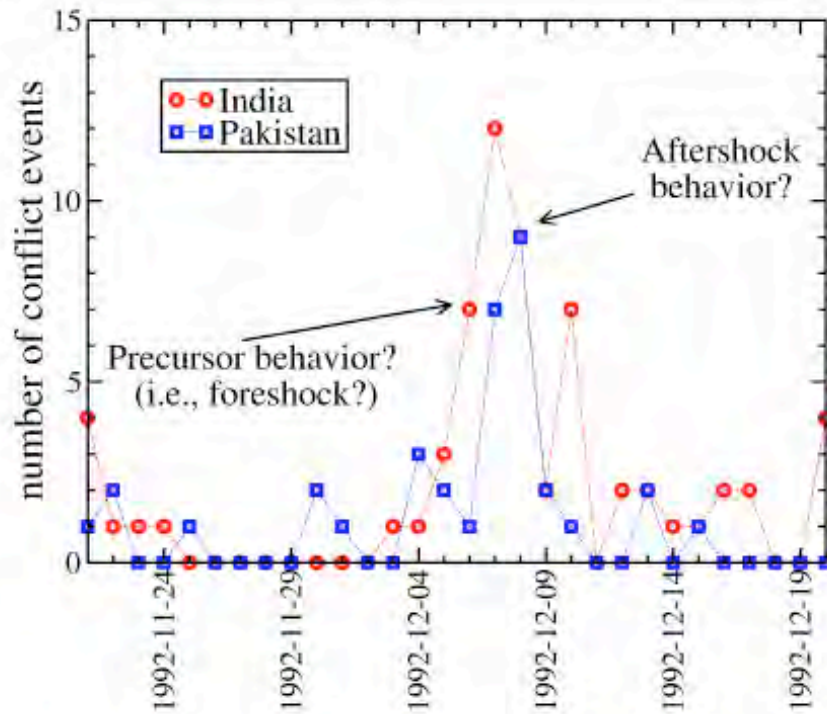
- Data extracted using Virtual Research Associates, Inc. (VRA) Reader <http://www.vranet.com>
- Software parses Reuters Business Briefing newswire
- Database of *source* and *target* actors, *type of event*
- 157 event types, 'all' countries, aggregated into *conflict* and *cooperation* time series, 1990-2005

24 conflict event types

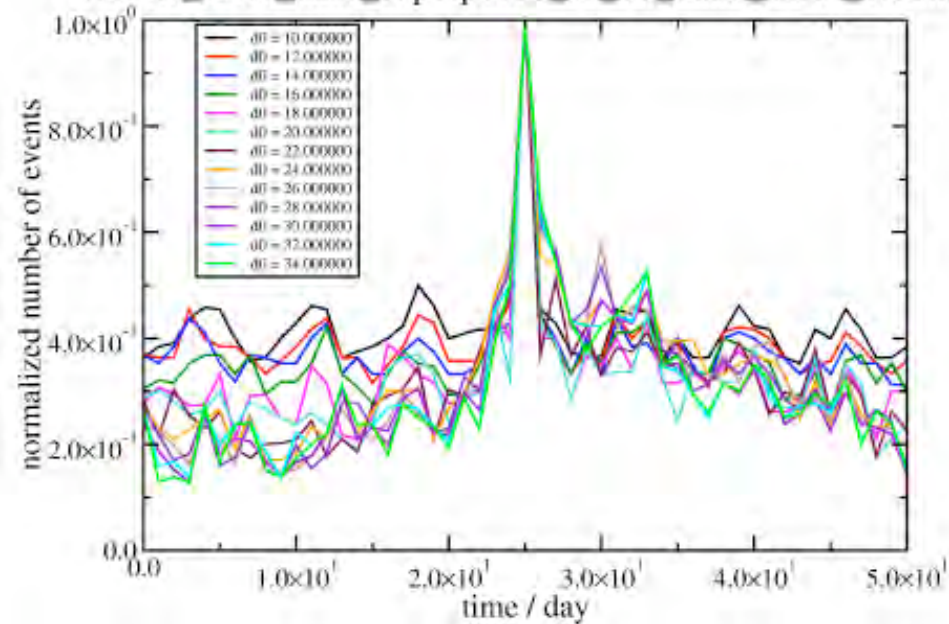
Abduction	Armed actions
Armed battle	Arrest and detention
Artillery attack	Assassination
Beatings	Bodily punishment
Coups and mutinies	Criminal arrests
Crowd control	Force use
Hijacking	Hostage and kidnapping
Mine explosion	Missile attack
Physical assault	Political arrests
Riot	Sexual assault
Small arms attack	Suicide bombing
Torture	Vehicle bombing

27 cooperation event types.

Acknow. respons.	Agree to mediation
Agree to negotiate	Agree to peacekeeping
Agree to settlement	Apologize
Collaborate	Demobilize armed forces
Ease sanctions	Empathize
Engage in negotiation	Evacuate victims
Forgive	Grant asylum
Host a meeting	Improve relations
Mediate talks	Observe truce
Offer peace proposal	Offer to Negotiate
Offer to mediate	Promise to mediate
Provide shelter	Relax curfew
Request mediation	Request withdrawal or ceasefire
Travel to meet	



violent_USA_time_superpos00_of_00_band_norm_median



Predicting the rise and fall of social and economic interactions by monitoring and modeling internet activities and commercial sales

- Books, Music, DVD,
- Electronics (audio and video, cameras and photography, software, computers and video games, cell phones. . .)
- Office
- Children and Babies
- Home and Garden (which includes pets)
- Gifts, Registries, Jewellery and Watches
- Apparel and Accessories
- Food
- Health, Personal Care, Beauty
- Sports and Outdoors
- Services (movies, restaurants, travel, cars, . . .)
- Arts and Hobbies
- Friends and Favourites

Research and Application questions

I- ACTION METRICS: what is the efficiency of ads campaigns? How to design them better?

How to manage in real time (or near-real time) and steer complex social systems, commercial sales, reputation branding, etc?

II- PREDICTING SUCCESS: forecast which product will be successful, where and how to allocate resources.

III-DYNAMICAL ENDO-EXO SEARCH: better search engine using the time dynamics of the endo-exo approach.