

The Economist

OCTOBER 27TH - NOVEMBER 2ND 2007 www.economist.com

Why Europe should vote on its treaty

Wall Street's jitters

Benazir Bhutto, after the blasts

Fighting Mexico's drug traffickers

A new approach to biology

Brains, not bullets

How to fight future wars?



USA:

Neil Johnson

Zhenyuan Zhao

Sean Gourley

George Tita

Nic Ducheneaut

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U.K.:

Mike Spagat

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Colombia:

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China:

Pak Ming Hui

Chen Xu



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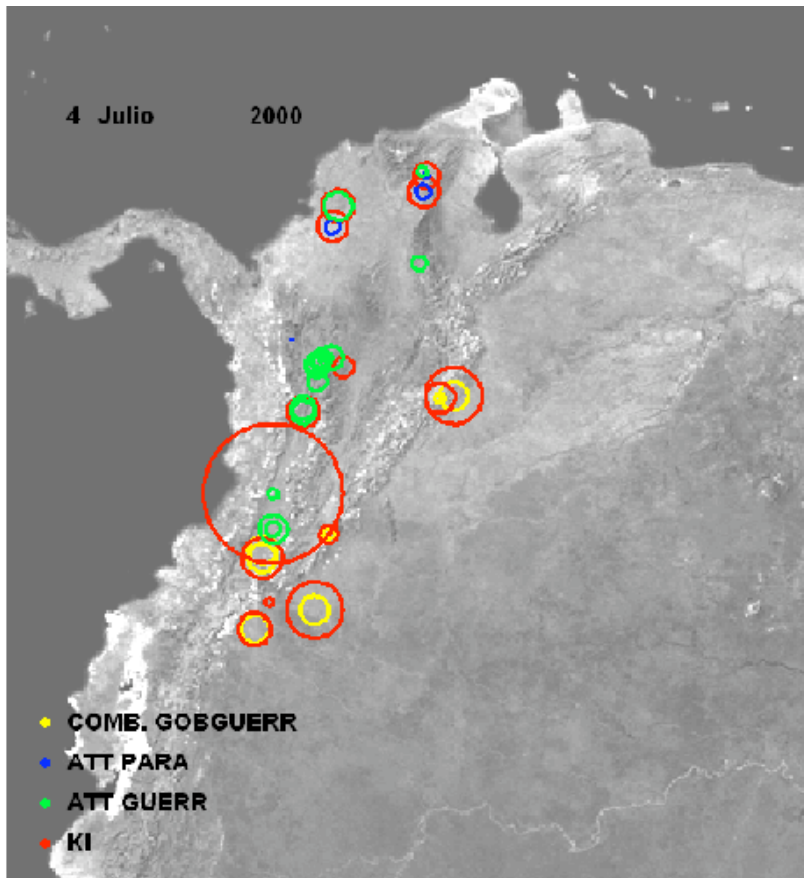
How to fight future wars?



Insurgent warfare



Online & offline gangs



Observation: **Common patterns in**
(1) insurgent wars, relation to
terrorism (Clauaset),
(2) street gangs and online games

Explanation: **Common ways in which**
humans 'do' groups

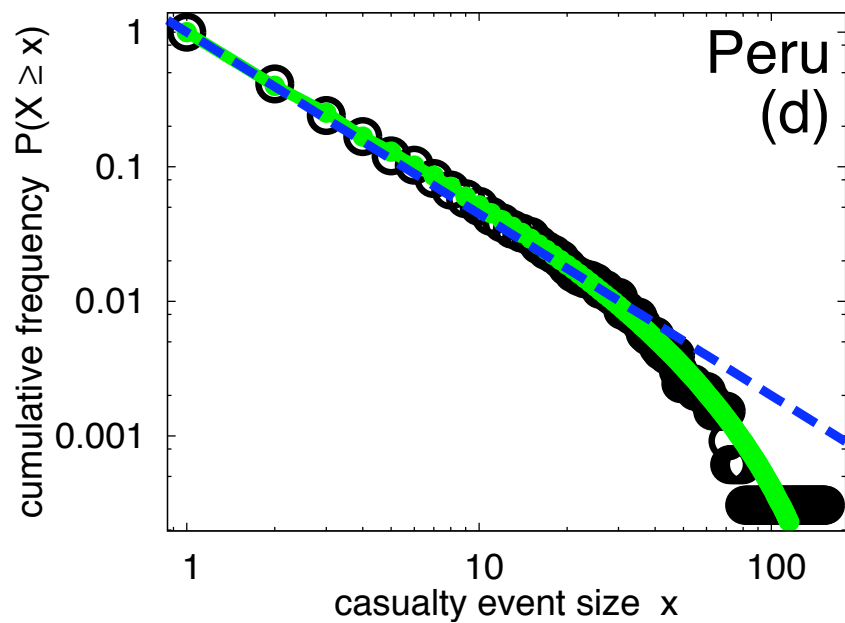
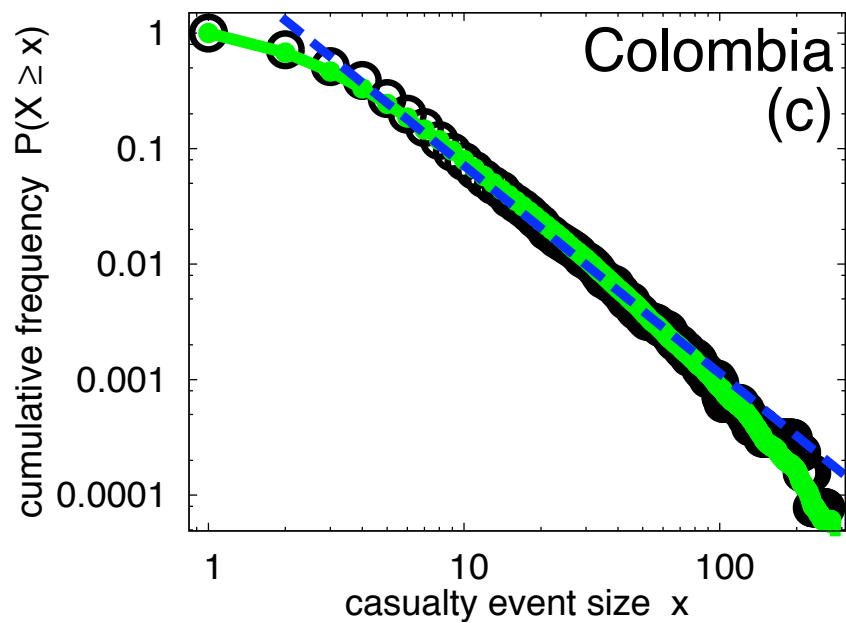
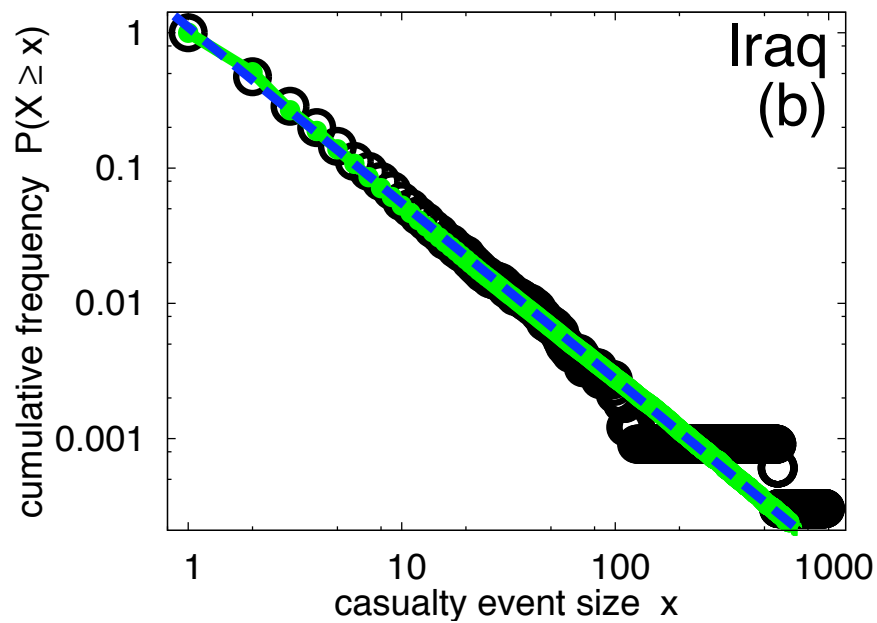
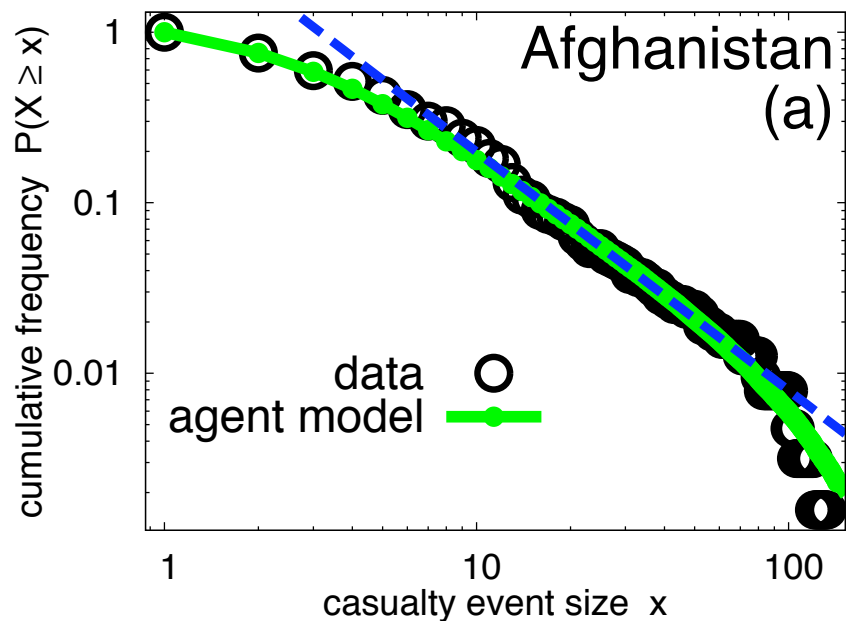
Theory: **Soup-of-groups**
No permanent hierarchy or leaders
Beyond power-law description

Practical use: **Create scenarios, discover**
black swans, risk, prediction

27 March 2007



.....10 injured in attack by Farc guerrillas, Buenaventura, Colombia — 2 shot dead in Shorja market, Baghdad — 11 police officers killed by explosives in Lashkar Gah, Afghanistan — 16 killed by suicide truck bomb in local restaurant, Ramadi, Iraq.....



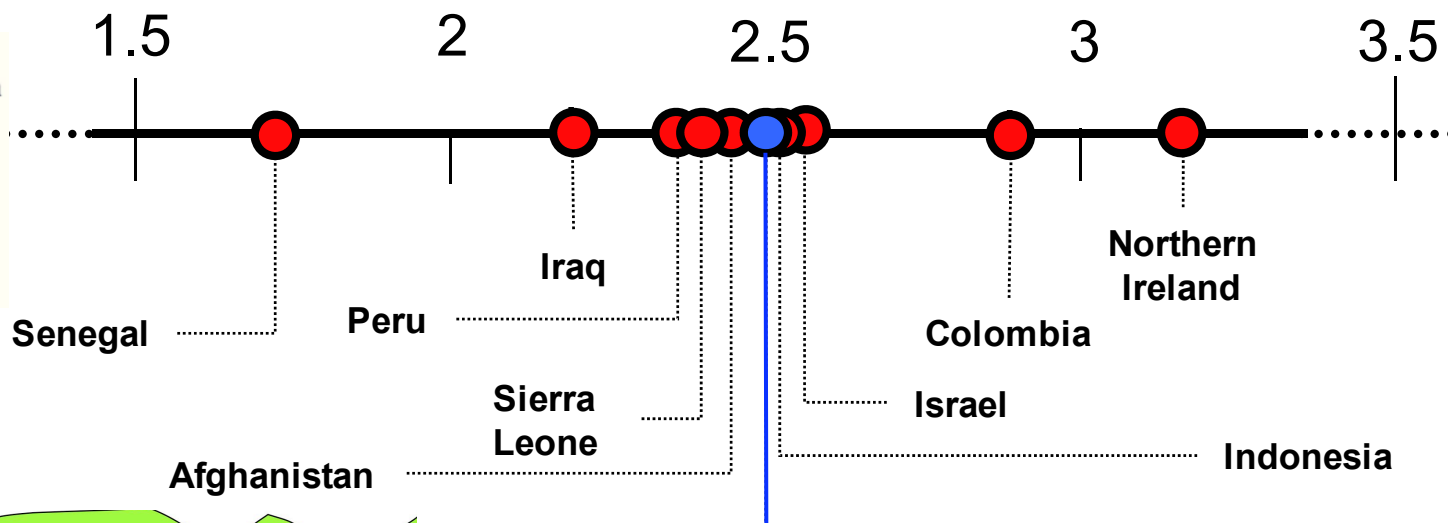
Power-law analysis follows
 Clauset, Shalizi, Newman
 arXiv:0706.1062

For $\alpha < 2$
 infinite mean, infinite standard deviation

For $2 < \alpha < 3$
 finite mean, infinite standard deviation

For $\alpha > 3$
 finite mean, finite standard deviation

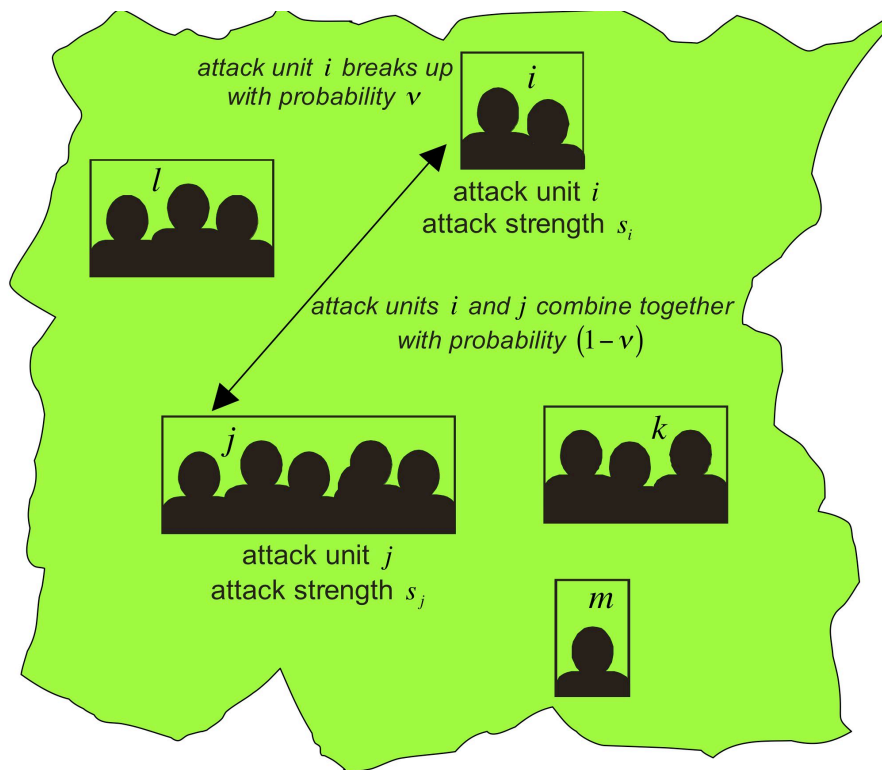
Slope of power-law for specific conflicts



Global terrorism death + injury: 2.48(7)
 Clauset et al. J. Confl. Res. (2007)

But why should a 2.5 power-law be a 0'th-order approximation for diverse insurgent conflicts and terrorism?

→ our 'soup of groups'
 fission-fusion model NFJ et al. 2005
[arXiv:physics/0506213](https://arxiv.org/abs/physics/0506213) [0605035](https://arxiv.org/abs/physics/0605035)

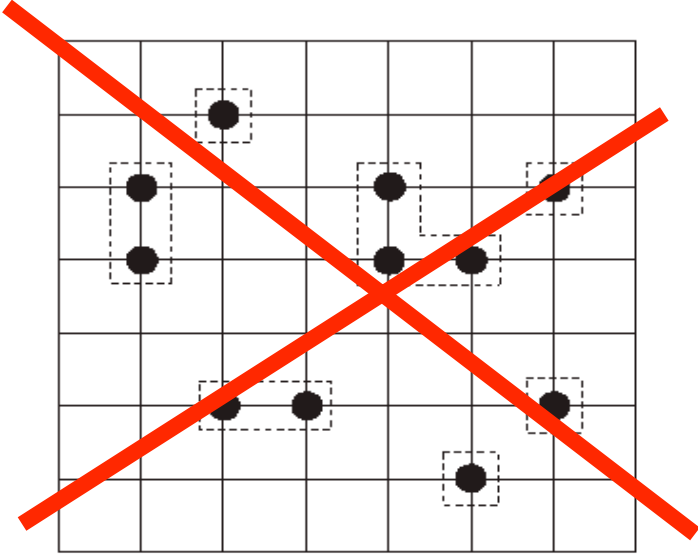




communication devices like mobiles and the internet. Some use it as part of their fight, others to survive.

David Kilcullen, senior policy adviser to Condoleezza Rice
 "...they're not doing that because they want to reduce the number of Humvees we have in Iraq by one. They're doing it because they want spectacular media footage of a burning Humvee."

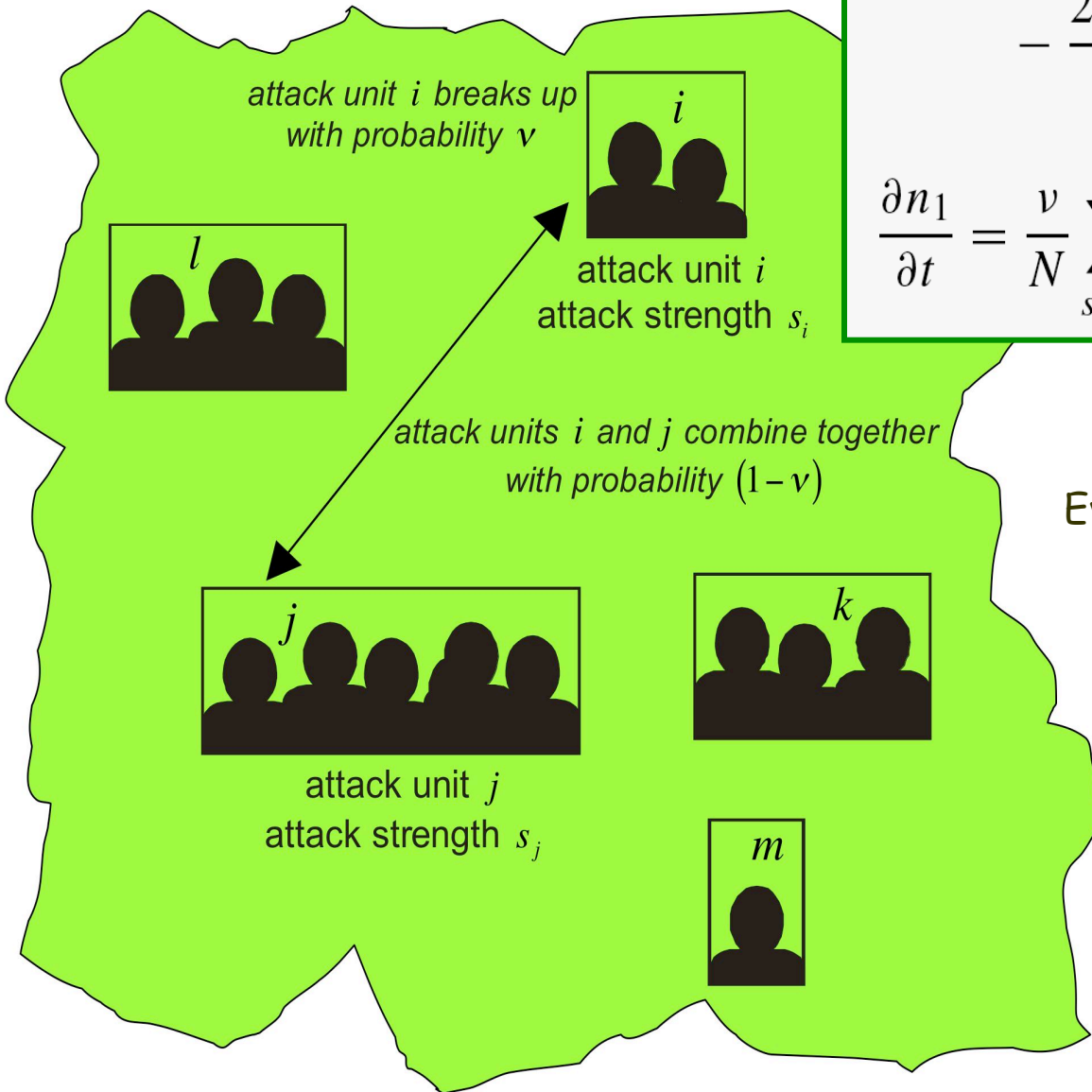
THE BIGGEST GANG IN IRAQ
 US soldier on patrol in Mosul Iraq, "This is like a gang war, and we are the biggest gang."



~~$$\frac{dR}{dt} = -gR^qG^p, \quad \frac{dG}{dt} = -rR^pG^q$$~~

'soup of groups' model (fission-fusion)

[LANL physics/0506213](http://LANL.physics/0506213) 0605035

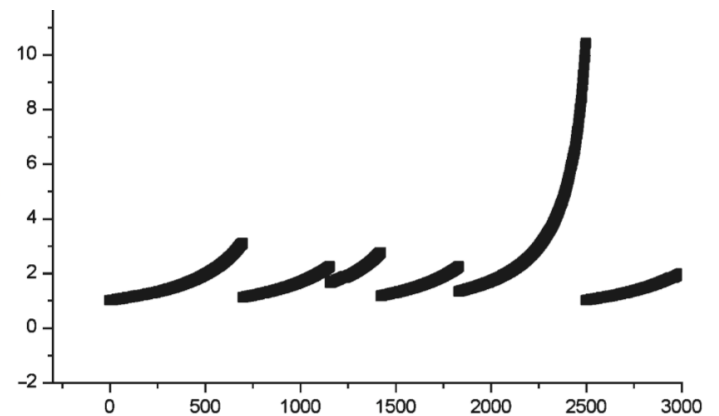


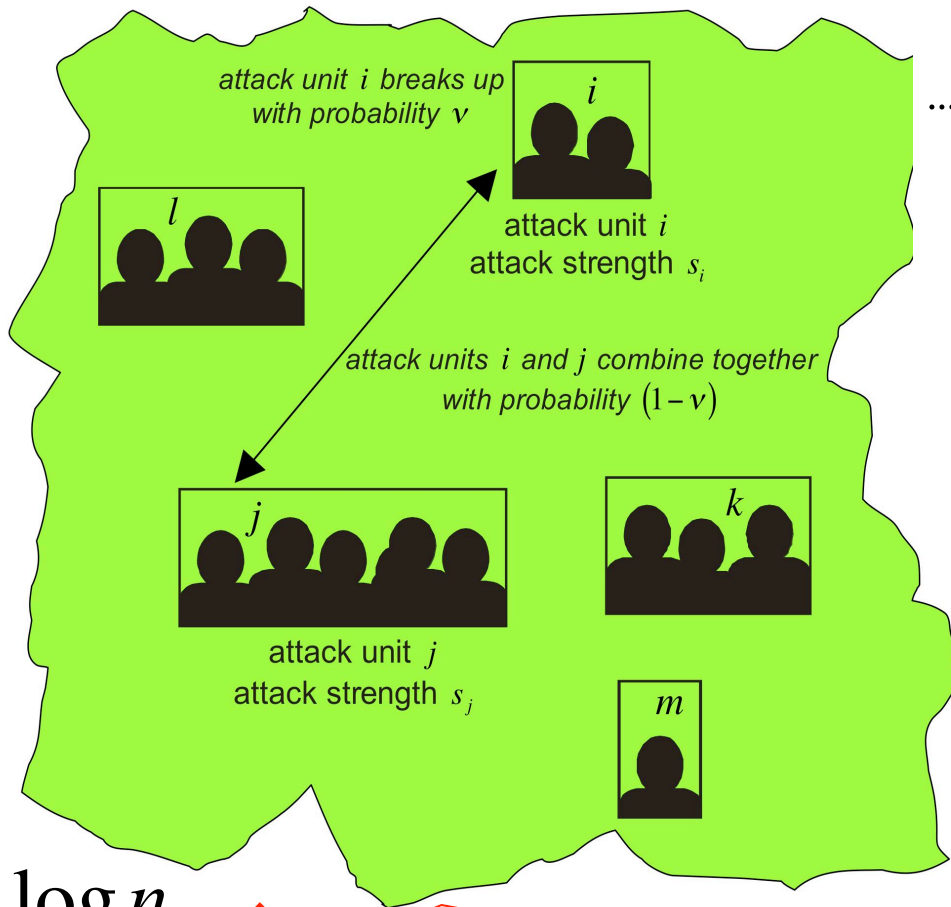
$$\frac{\partial n_s}{\partial t} = -\frac{\nu s n_s}{N} + \frac{(1 - \nu)}{N^2} \sum_{s'=1}^{s-1} s' n_{s'} (s - s') n_{s-s'}$$

$$- \frac{2(1 - \nu) s n_s}{N^2} \sum_{s'=1}^{\infty} s' n_{s'}, \quad \text{for } s \geq 2$$

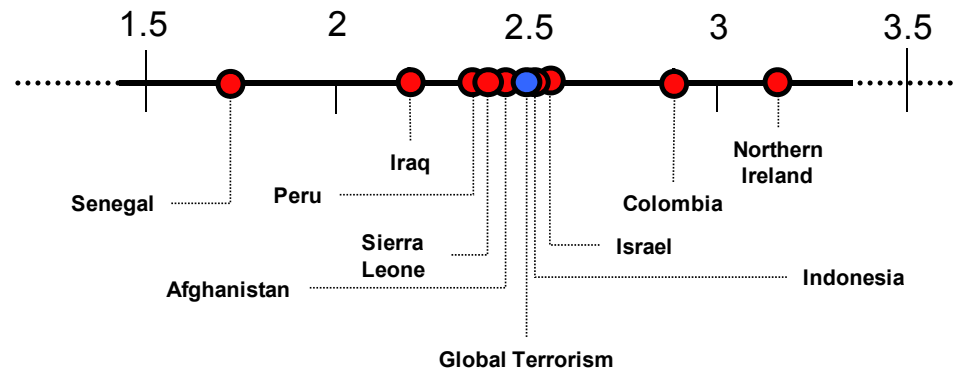
$$\frac{\partial n_1}{\partial t} = \frac{\nu}{N} \sum_{s'=2}^{\infty} (s')^2 n_{s'} - \frac{2(1 - \nu) n_1}{N^2} \sum_{s'=1}^{\infty} s' n_{s'}.$$

Evolution of largest attack unit in time
(population = 1000 insurgents)





Slope of power-law for specific conflicts

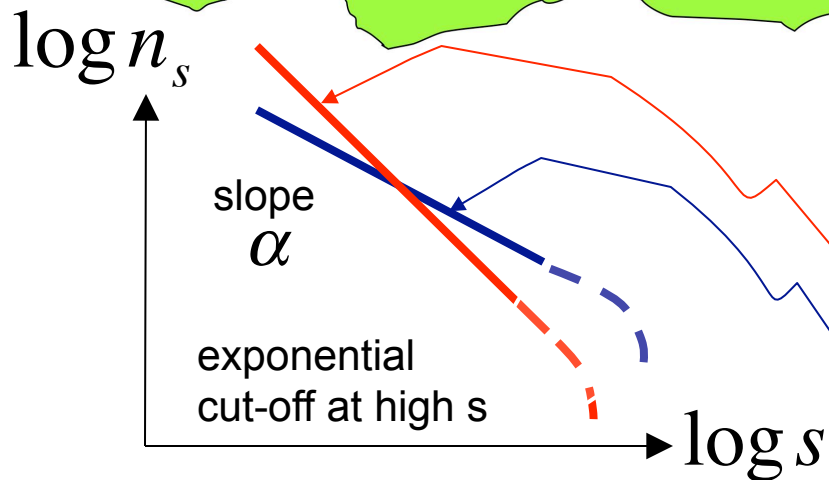


Solve equations in steady-state:

$$n_s \sim s^{-\frac{5}{2}} = 2.5$$

Modifying the probability of coalescence-fragmentation so that larger attack units are more rigid, gives

$$n_s \sim s^{-(2.5 - \delta)}$$

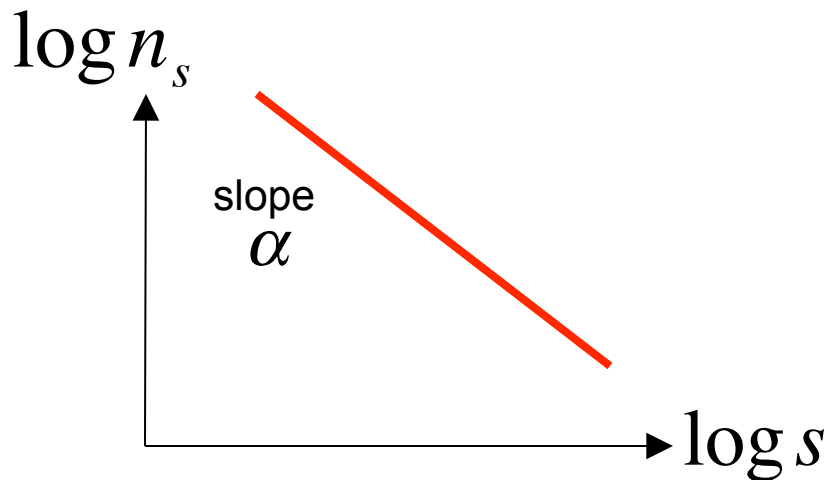


$\delta = 0$ corresponds to a power-law with $\alpha = 2.5$

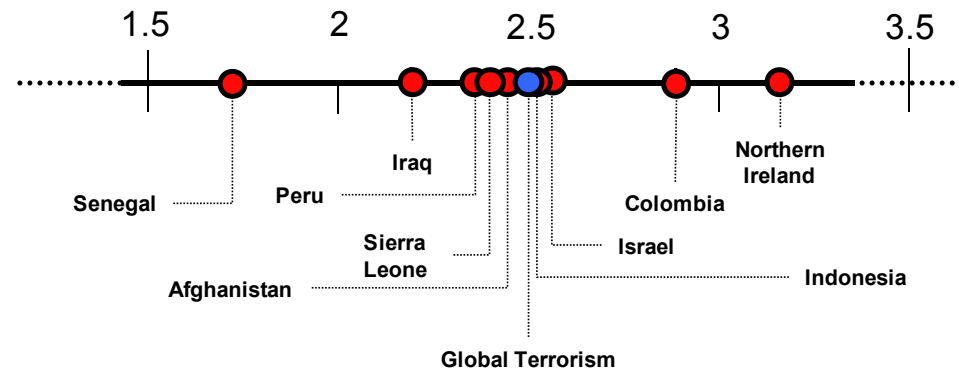
$\delta = 0.7$ corresponds to a power-law with $\alpha = 1.8$

2.5 power-law distribution is an 'attractor' for many model generalizations:

1. Multiple (i.e. > 2) units coalesce
 2. Fragmentation into units $s_0 > 1$
 3. Fluctuating population size N
 4. Heterogeneous characters
e.g. multiple factions/identities/roles
- + some realistic interventions etc.



Slope of power-law for specific conflicts



Solve equations in steady-state:

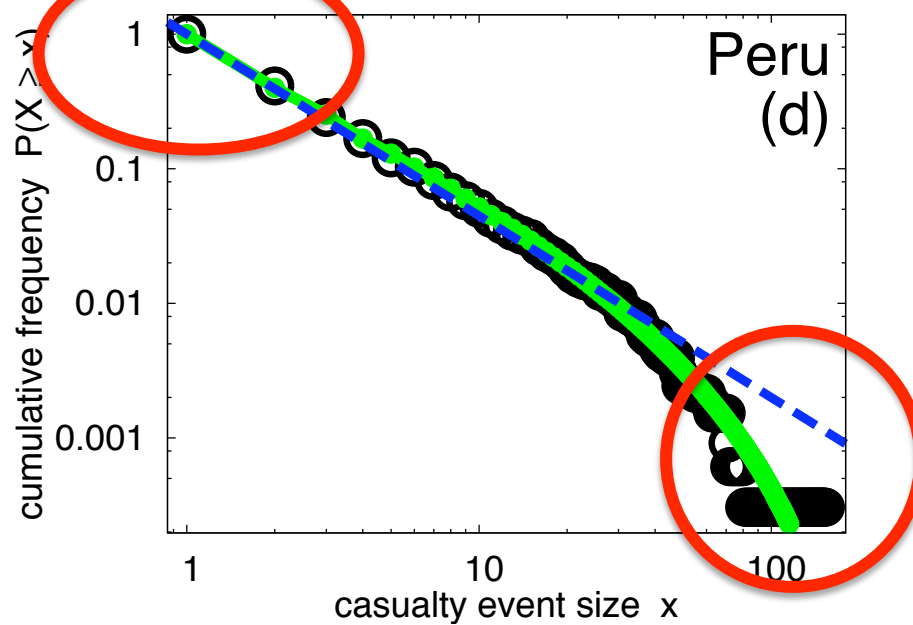
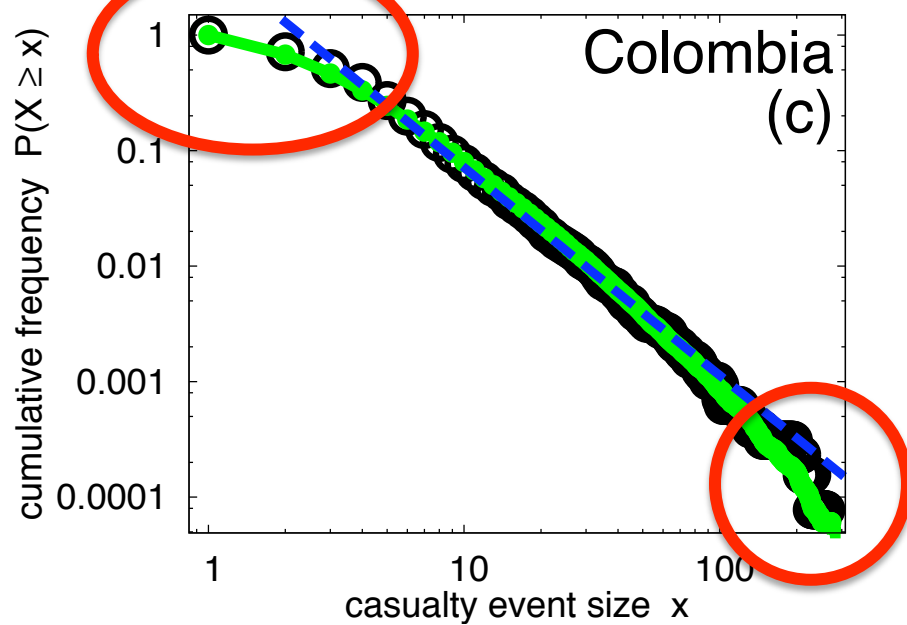
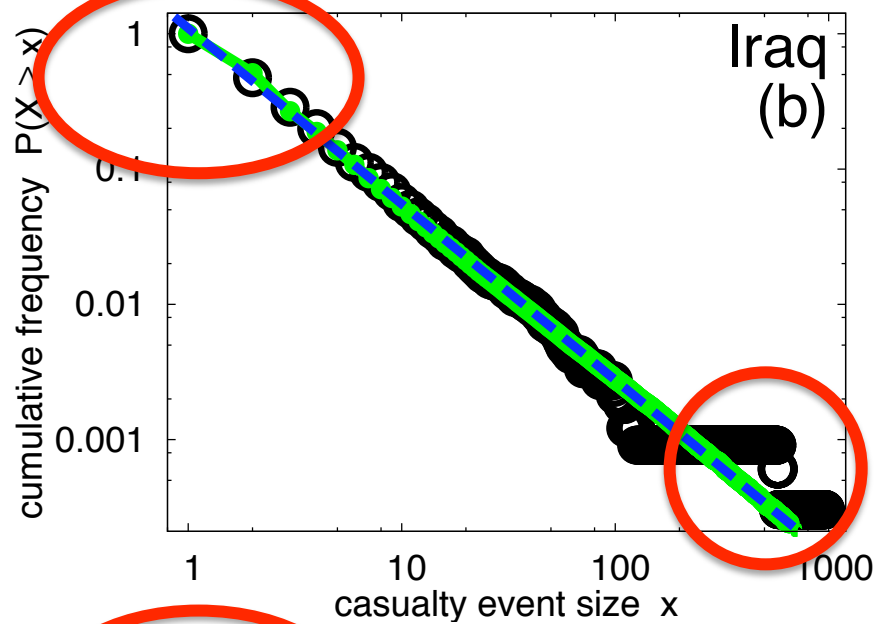
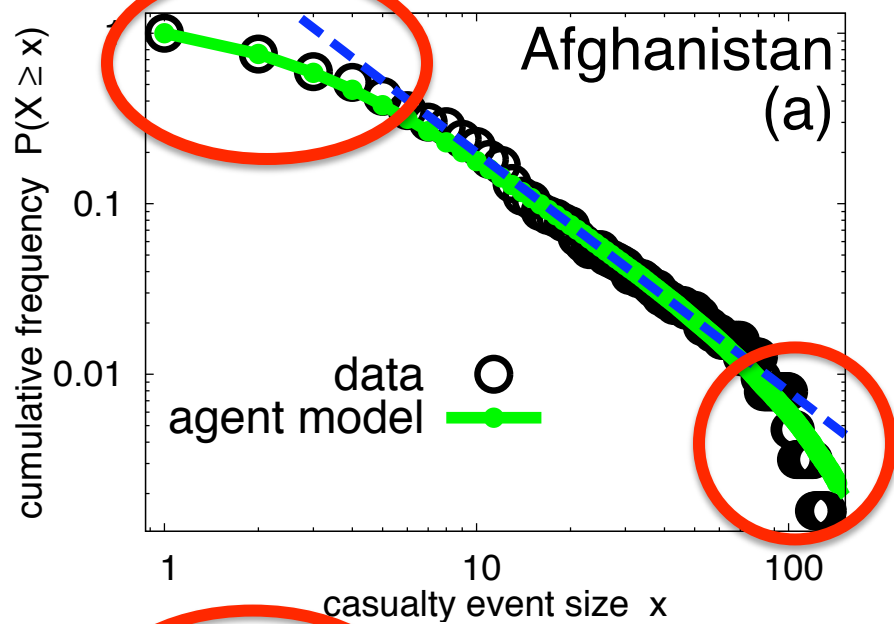
$$n_s \sim s^{-\frac{5}{2}} = 2.5$$

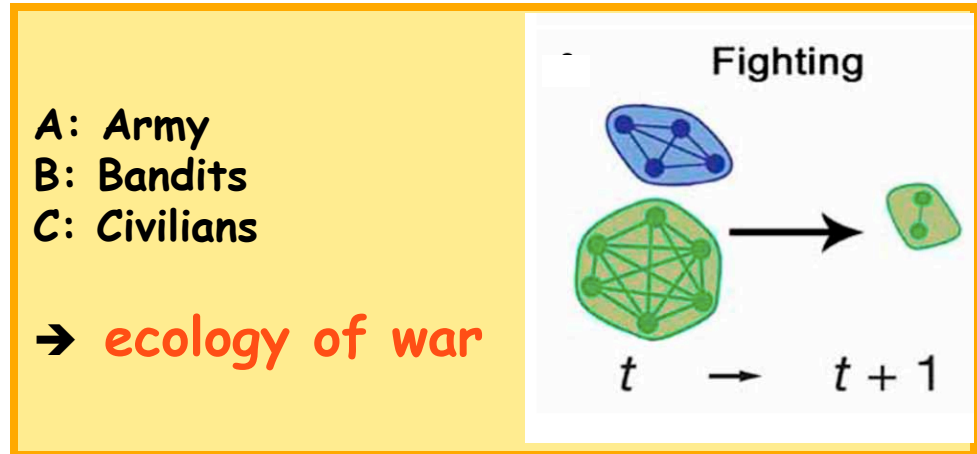
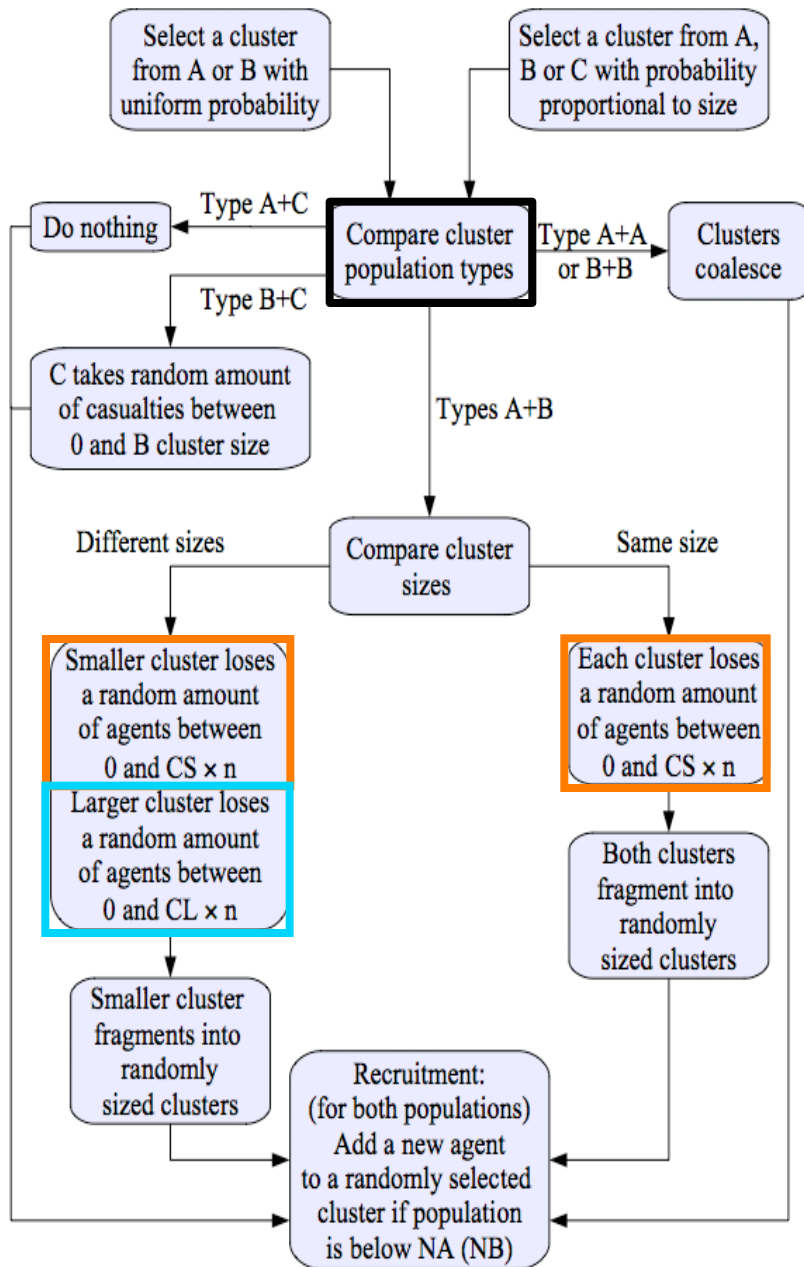
Fragmentation into many small parts makes sense for conflict, and is key for power-law near 2.5

c.f. binary fission (Gueron-Levin)

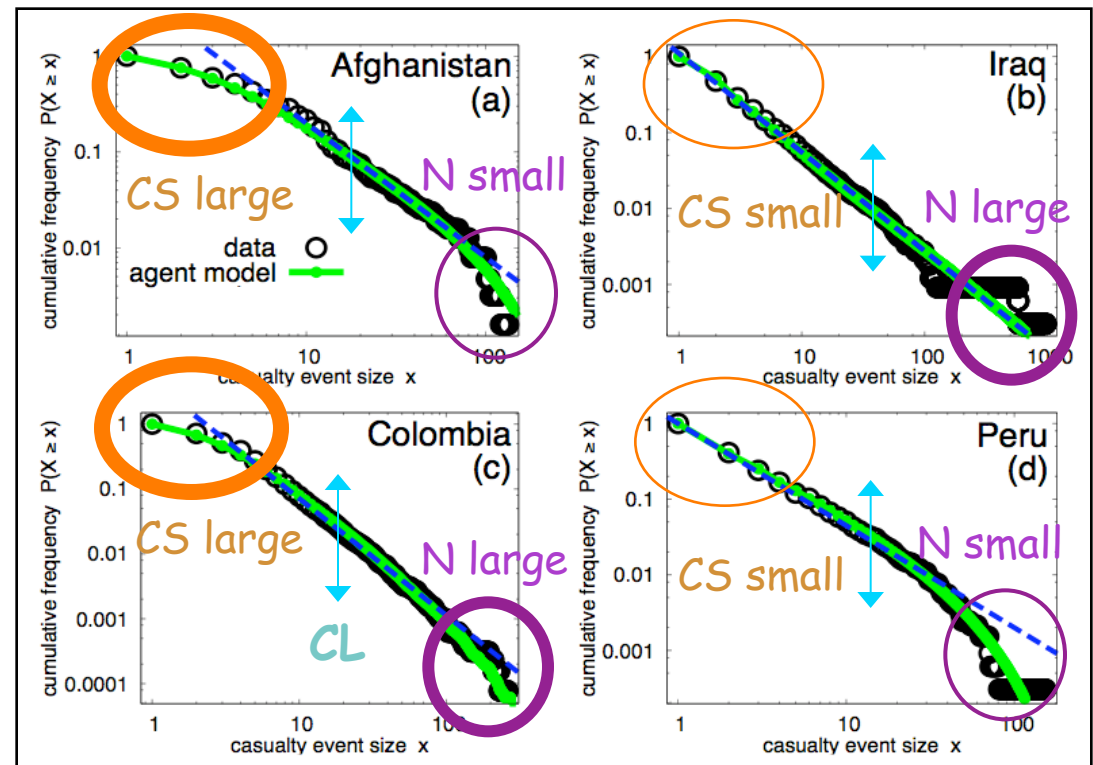
[Ruszczycki, NFJ et al.](#)
[arXiv:0808.0032](#)

Beyond power laws . . .

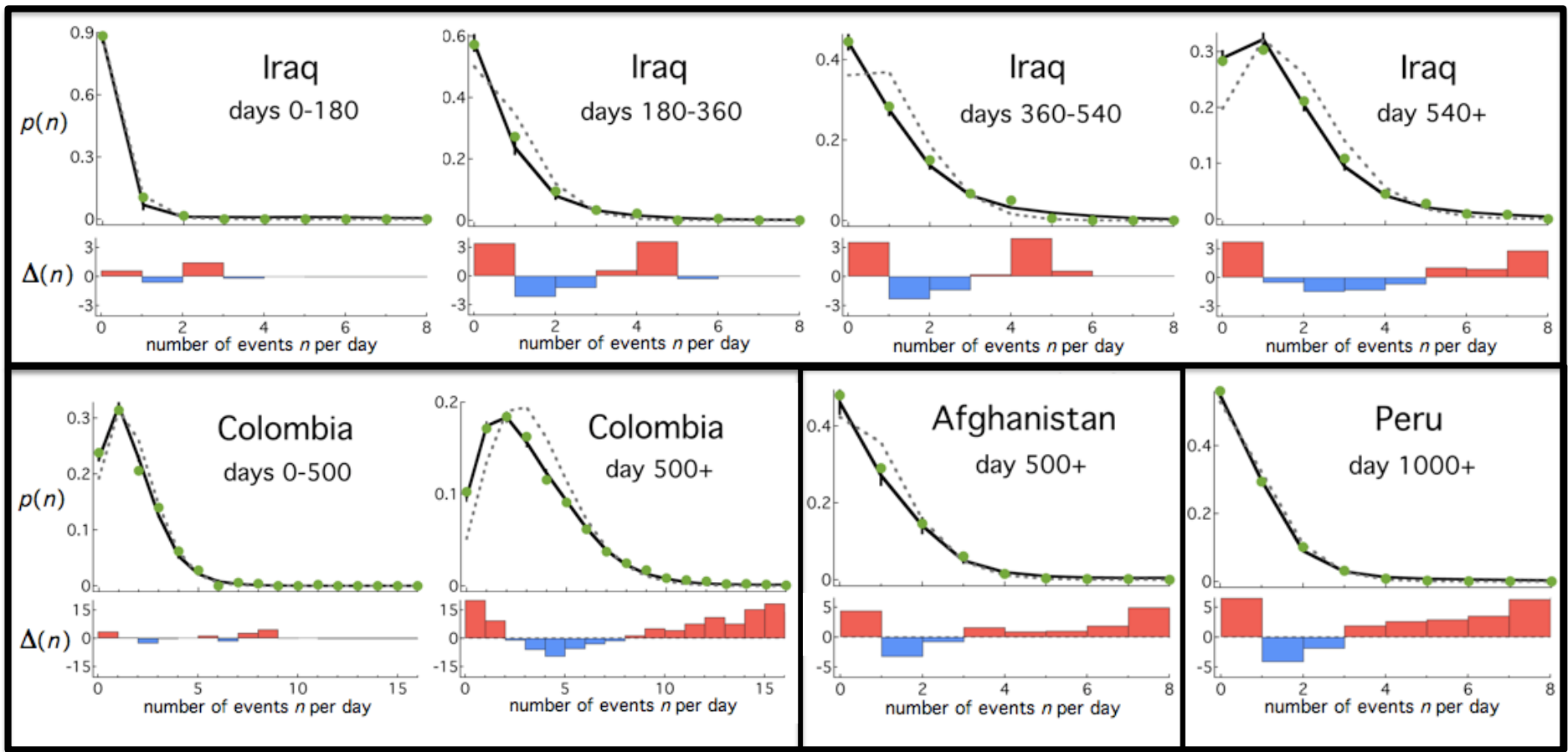
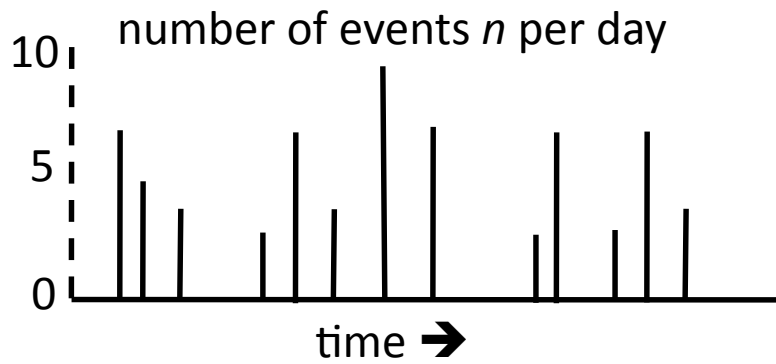




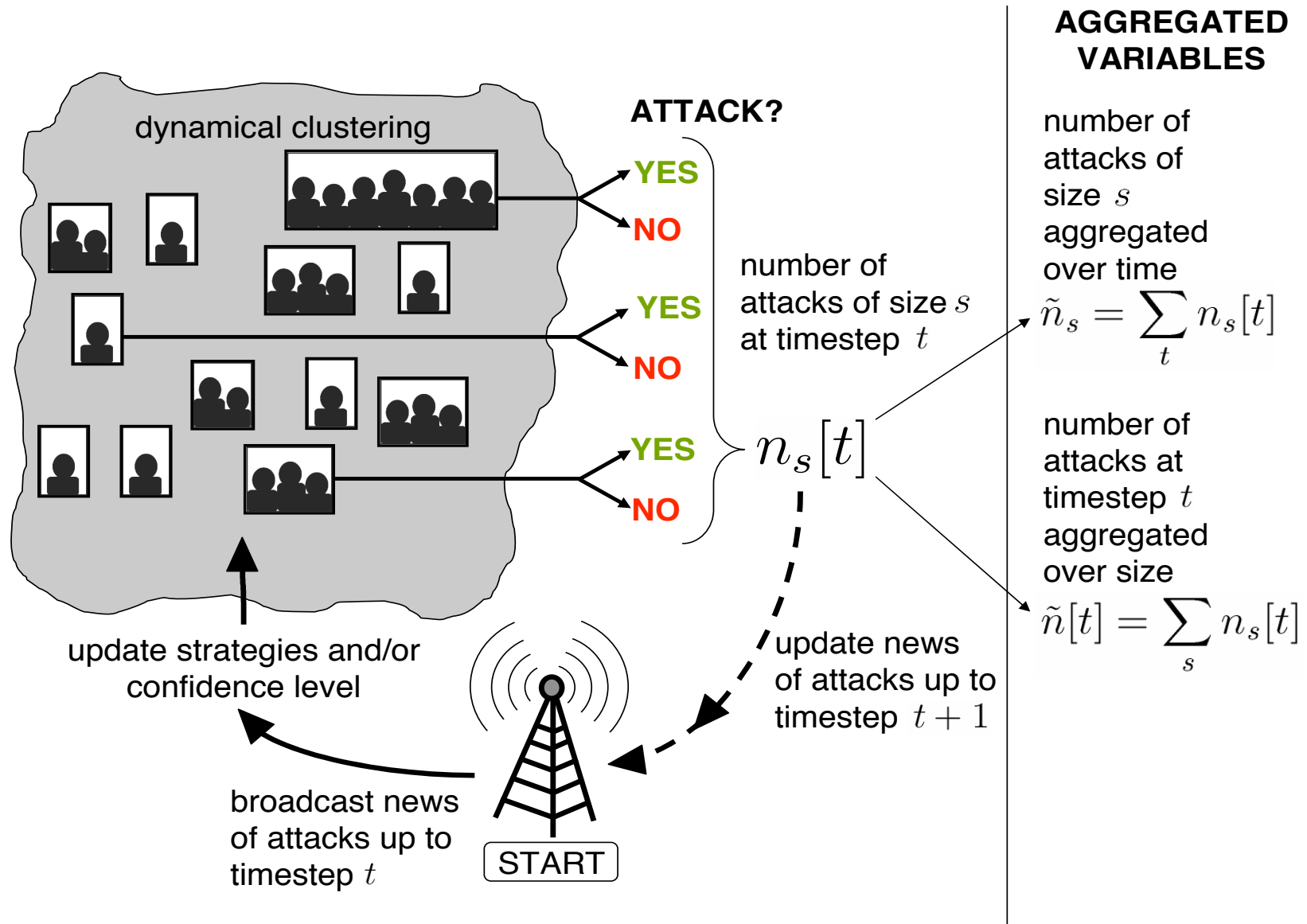
deviation \rightarrow dominant mechanisms in specific conflict

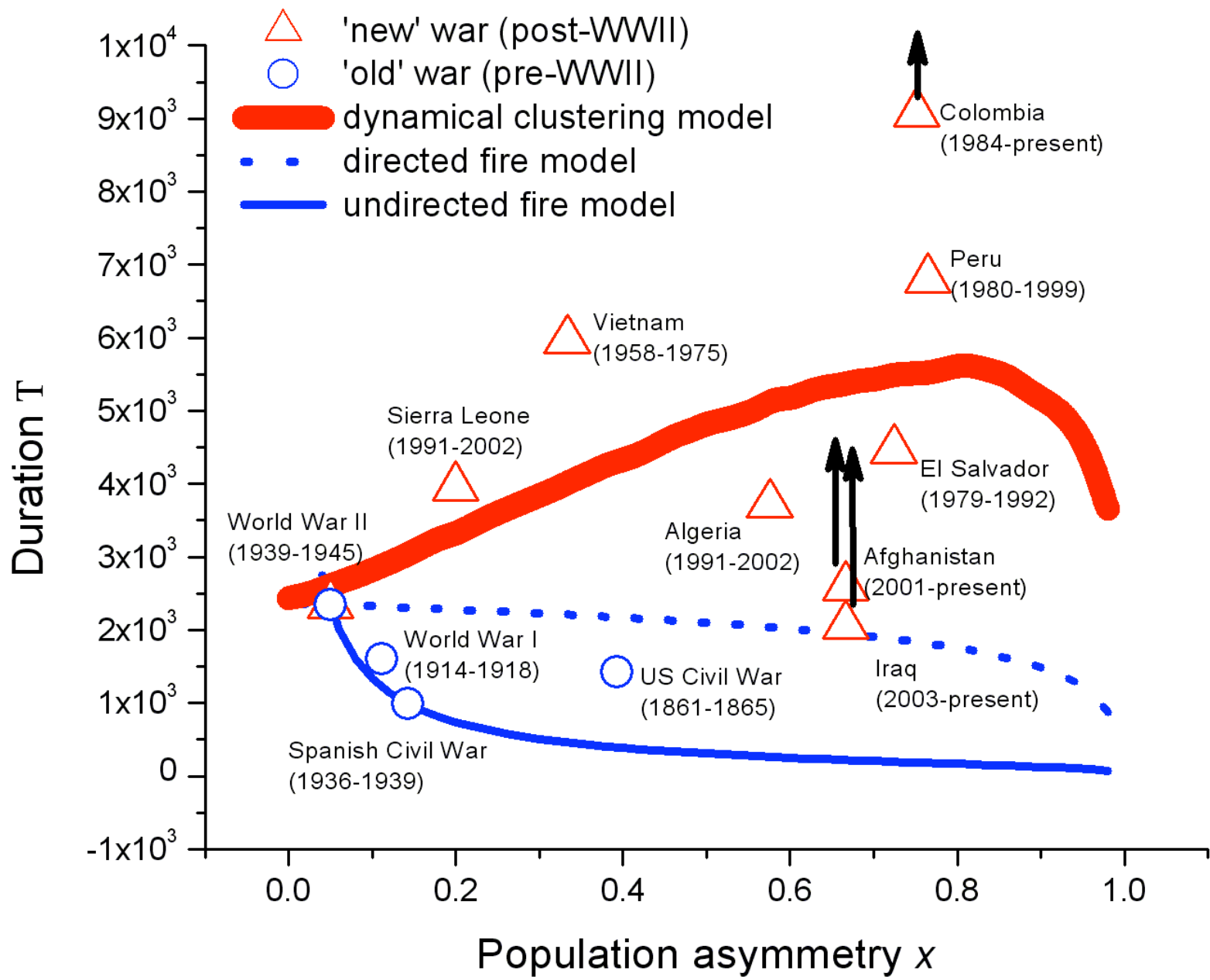


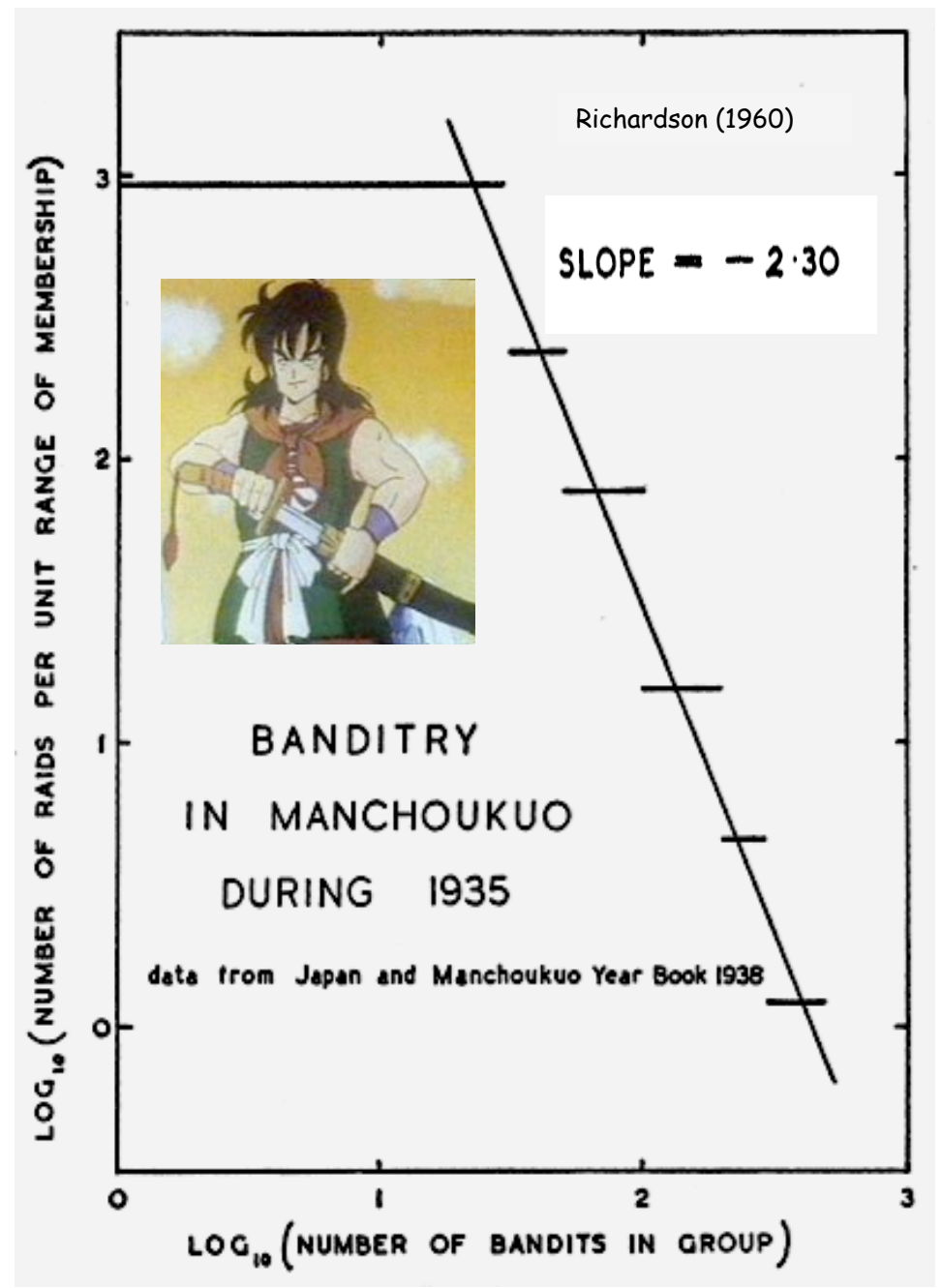
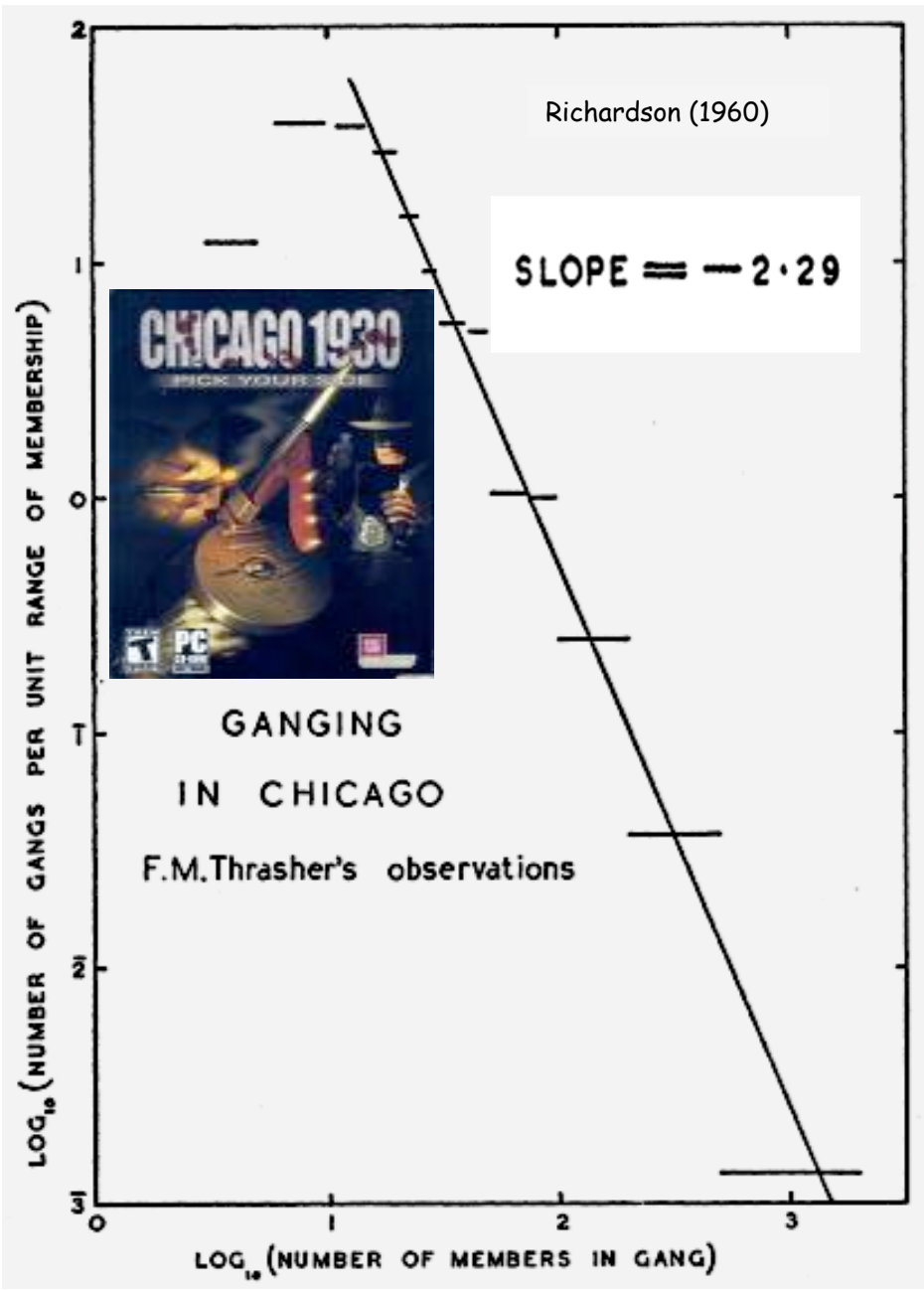
$N = N_A + N_B$ use empirical values



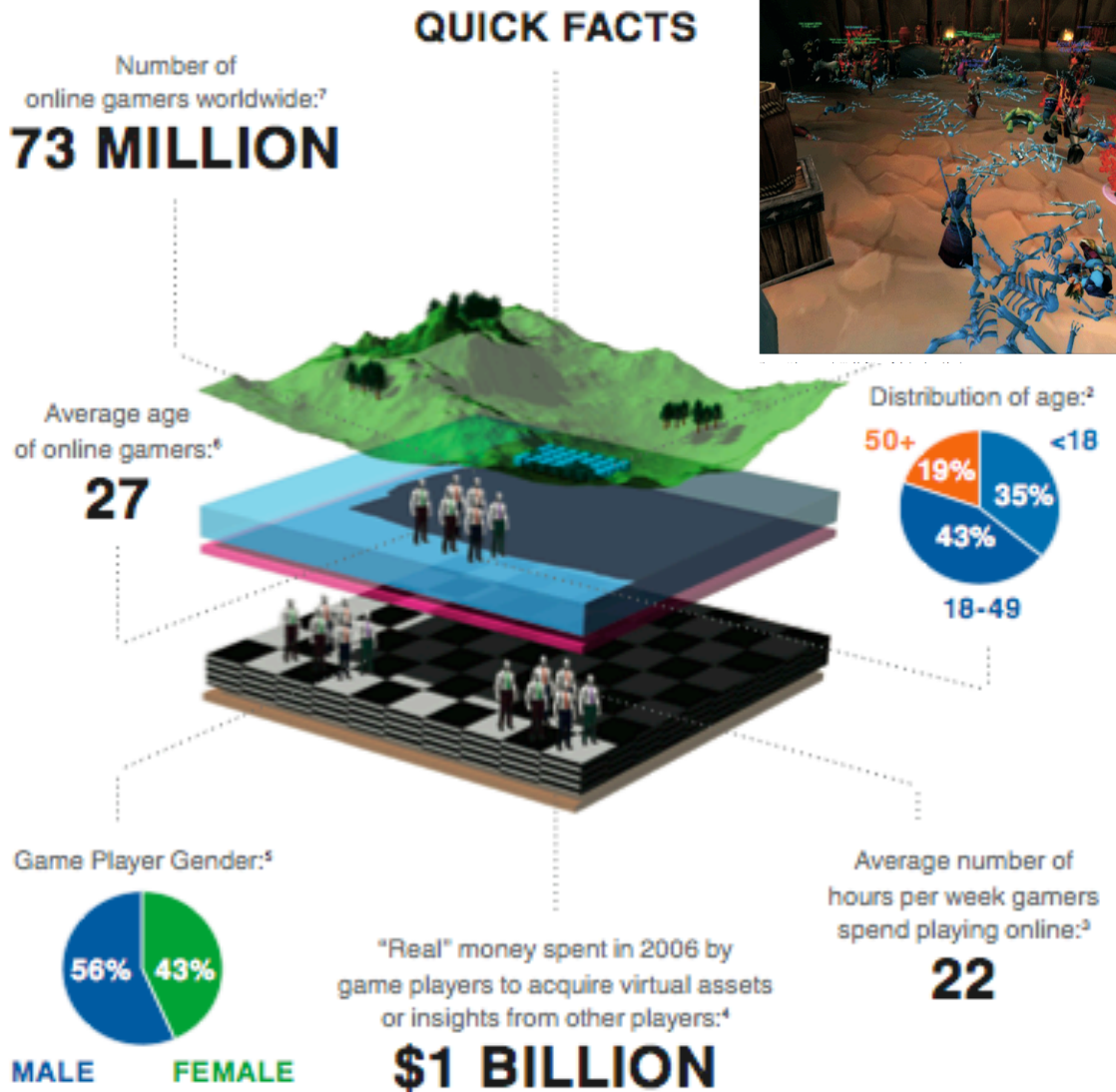
→ a unified model of insurgent war







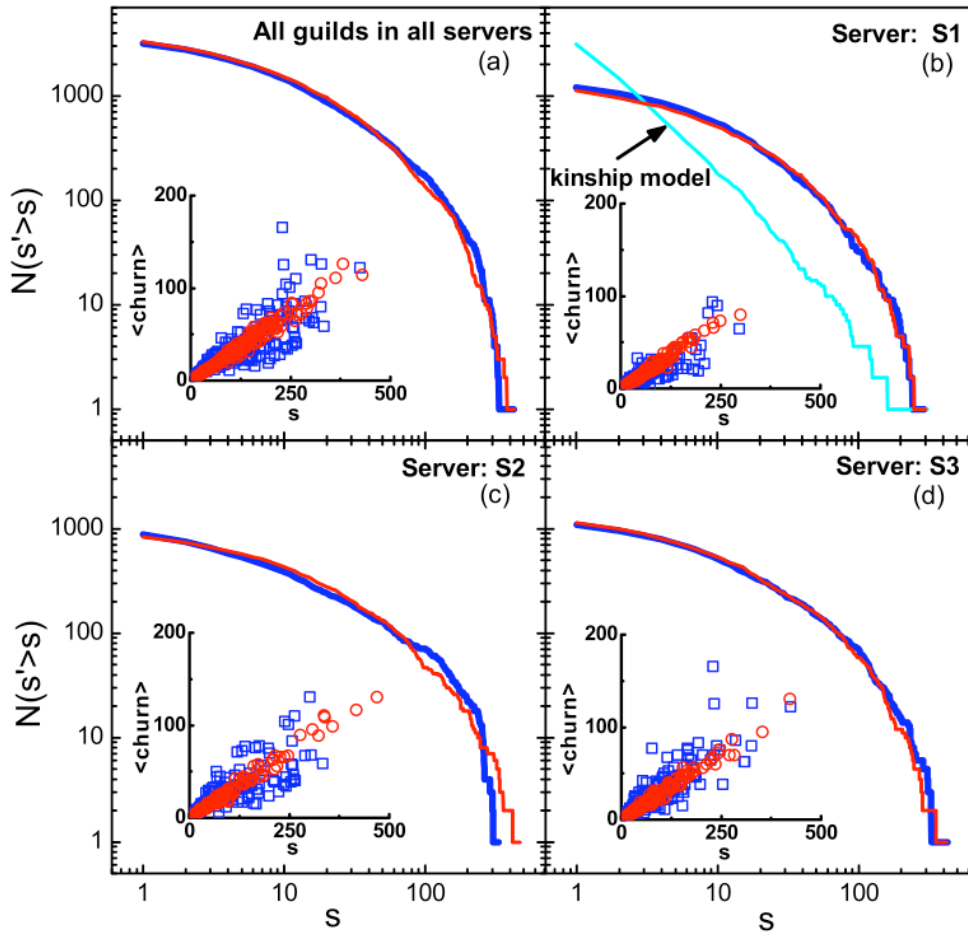
Online groups, e.g. guilds in World of Warcraft



Offline groups: LA street gangs

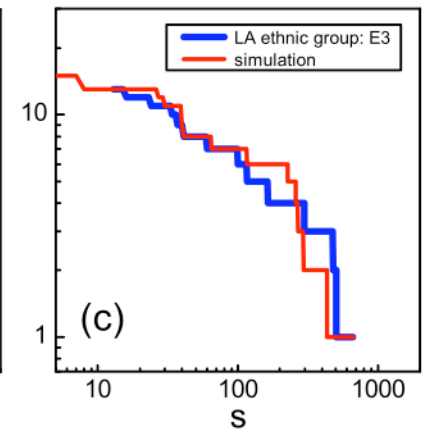
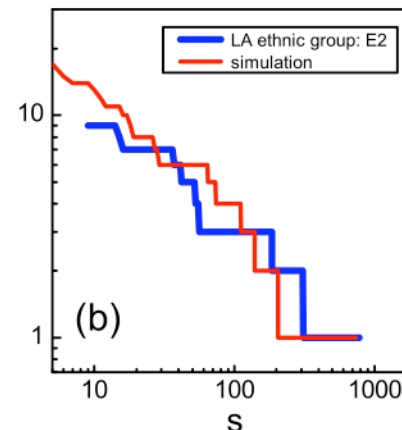
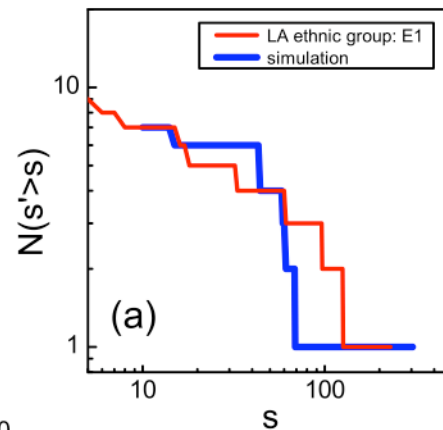
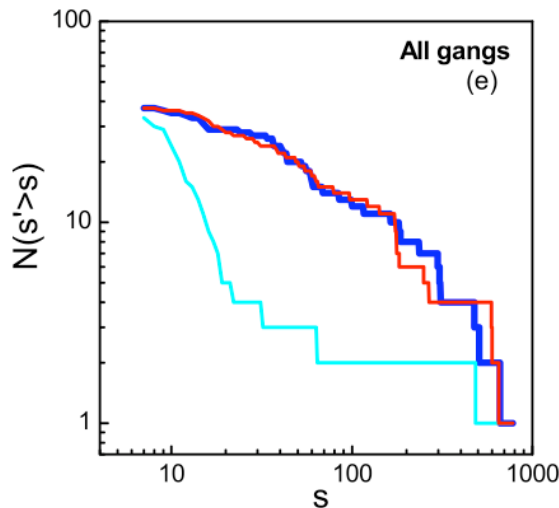
- Brick Block Boy Crips
- Crazy Brothers Clan
- Crazy Krooks
- Exotic Foreign Creation
- Insane Crips
- Long Beach Suicidal Punks
- Lunatics on Crack
- Naughty-nasty
- Tonga for Life
- Westside Longos etc.



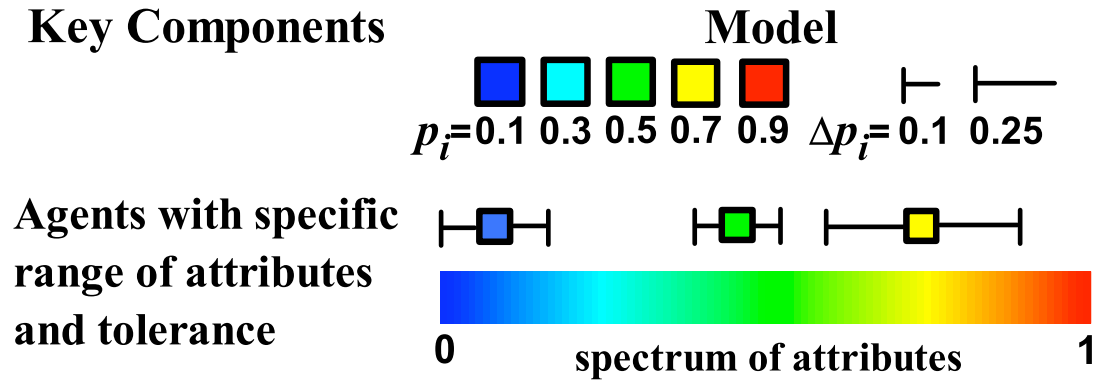


NFJ et al., Phys. Rev. E (2009)

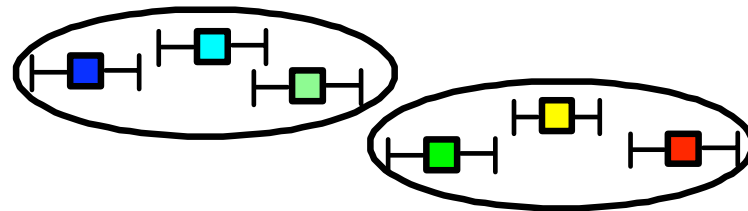
- LA gang and World of Warcraft guild size distributions do not look similar
- neither one is a good power-law
- difficult for candidate model to reproduce group size distribution *and* churn
- team model (dark blue) and empirical data (red) in good agreement
- kinship model (light blue) is not
- online server acts like offline ethnicity



Key Components



Team formation



Teams with members covering different attributes

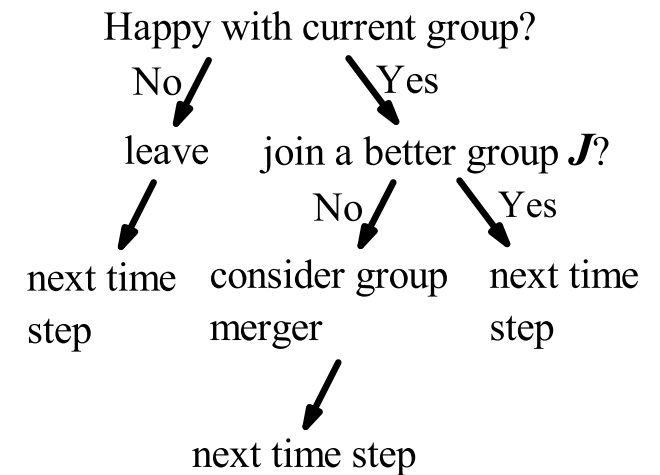
Kinship formation



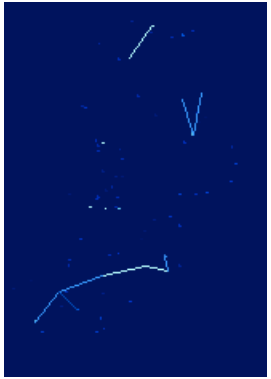
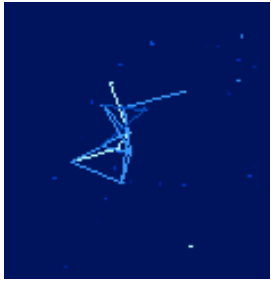
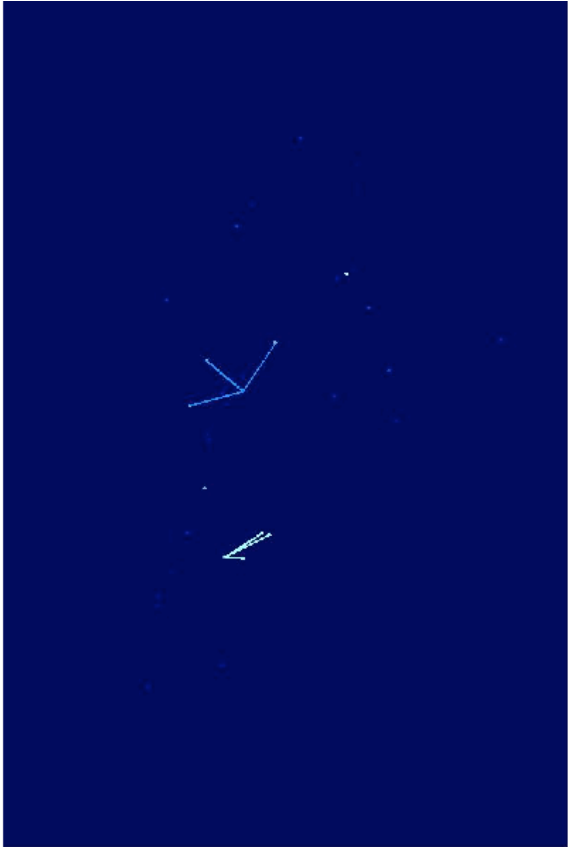
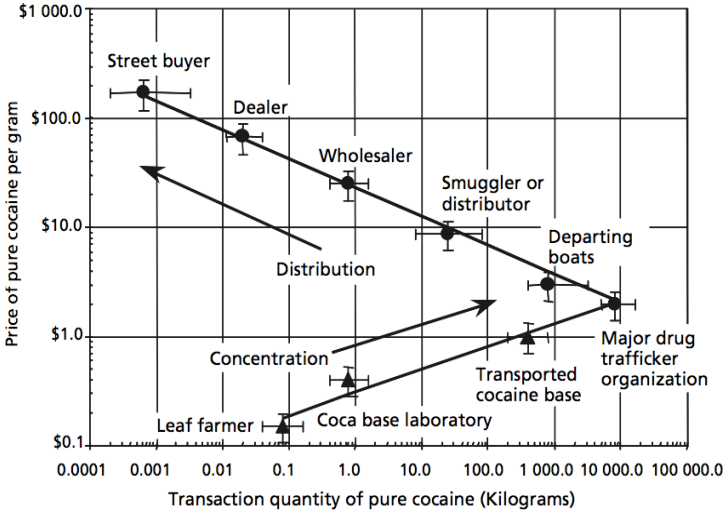
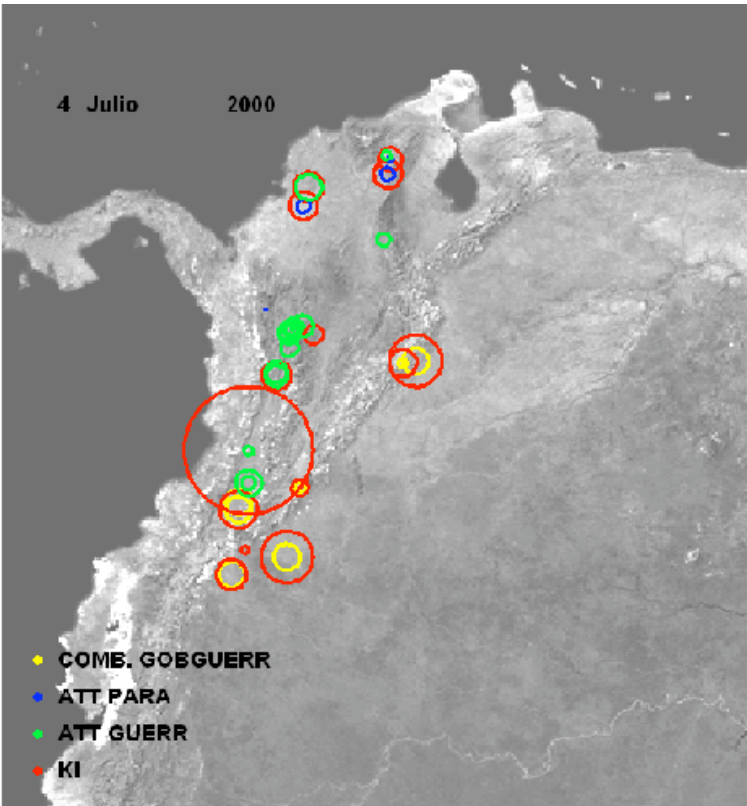
Groups with members of similar attributes

Implementation

- i^{th} agent randomly assigned attribute parameters p_i and Δp_i
- i^{th} agent assigned tolerance τ_i
 $\tau_i = \tau$ for all agents
- Each time step, randomly pick an agent i



Derivatives: Trafficking drugs, stolen goods (including people) etc.



motifs

In progress . . .

Conclusions

1. **Common quantitative patterns in insurgent warfare & terrorism**

Generic way in which humans 'do' insurgency and terrorism

Similar soup-of-groups. No permanent network hierarchy or leaders needed

2. **Law for 'Future' Wars ?**

Unified model of sizes and timings of events

Event sizes:

v1.0: One population soup-of-groups → approximate power-law, slope near 2.5

v2.0: Two population soup-of-groups gives details beyond power-law

Event timings:

v1.0: Probability of acting

v2.0: Decision-making, driven by competition for limited resource (media attention)

Group dynamics:

v1.0: Probabilistic fission-fusion

v2.0: Character-based team formation. Connection to gangs, Internet warfare.