Toward a non-equilibrium approach to political violence

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Santa Fe Institute, January 10-12, 2008

Outline

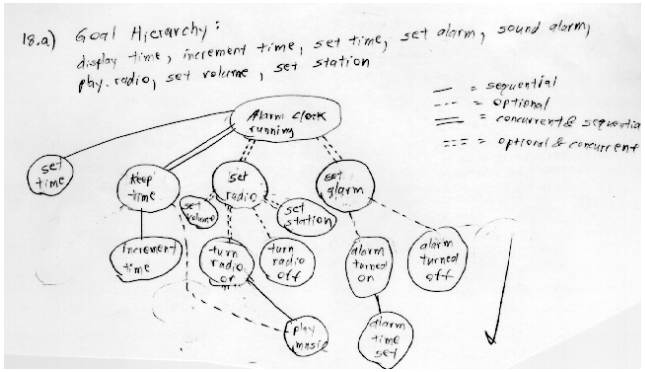
1. From “old” to “new” physics of social phenomena
2. Empirical evidence about conflicts
3. A computational model of interstate warfare
4. New evidence and future challenges

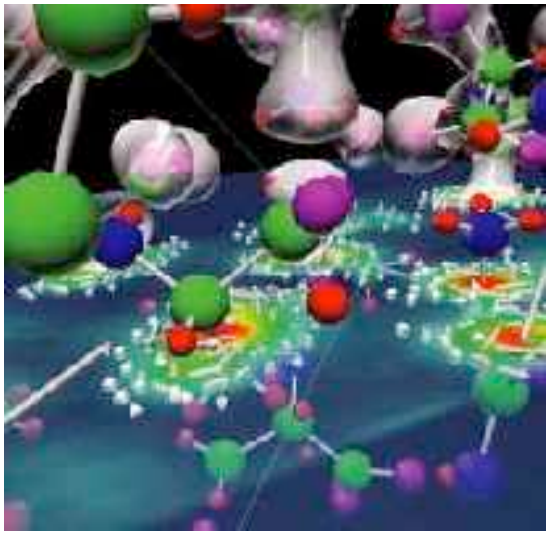
From "old" to "new" physics of social phenomena

Analytical	→	Synthetic approach
Equilibrium	→	Non-equilibrium theory
Nomothetic	→	Generative method
Variable-based	→	Configurative ontology

Analytical ➔ Synthetic approach

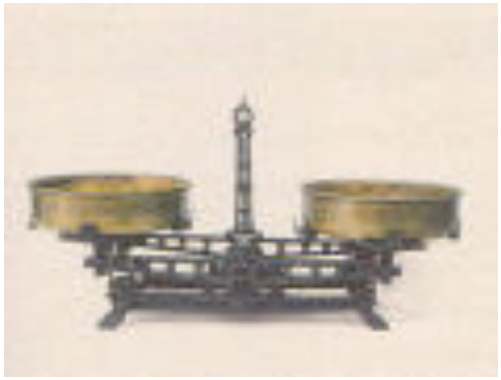
- Hope to solve problems through strategy of “divide and conquer”
- Need to make *ceteris paribus* assumption
- **But** in complex systems this assumption breaks down
- Herbert Simon: Complex systems are composed of large numbers of parts that interact in a non-linear fashion
- Need to study interactions explicitly





Equilibrium → Non-equilibrium theory

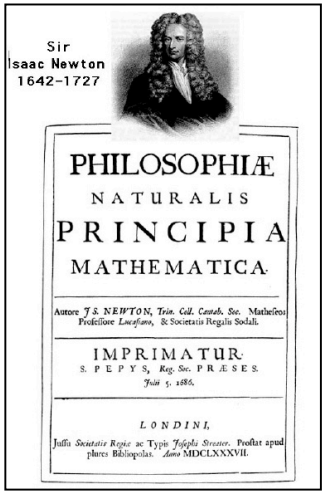
- Standard assumption in the social sciences: “efficient” history
- **But** contingency and positive feedback undermine this perspective
- Complexity theory and non-equilibrium physics
- Statistical regularities at the macro level despite micro-level contingency

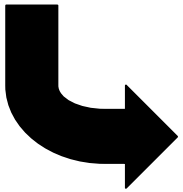


Example: Avalanches in rice pile

Nomothetic ? Generative method

- Search for causal regularities
- Hempel's "covering laws"
- **But** what to do with complex social systems that have few counterparts?
- Scientific realists explain complex patterns by deriving the mechanisms that generate them
- Axelrod: "third way of doing science"
- Epstein: "if you can't grow it, you haven't explained it!"





Variable-based ? Configurative ontology

- Conventional models are variable-based
- Social entities are assumed implicitly
- **But** variables say little about social forms
- A *social form* is a configuration of social interactions and actors together with the structures in which they are embedded
- Statistical physics and computational modeling help us endogenizing actors and their interactions explicitly

$$y = a + bx$$

where:

$$a = \frac{\sum y - b\sum x}{n}$$

$$b = \frac{n\sum(xy) - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2}$$

Balance of power and beyond…

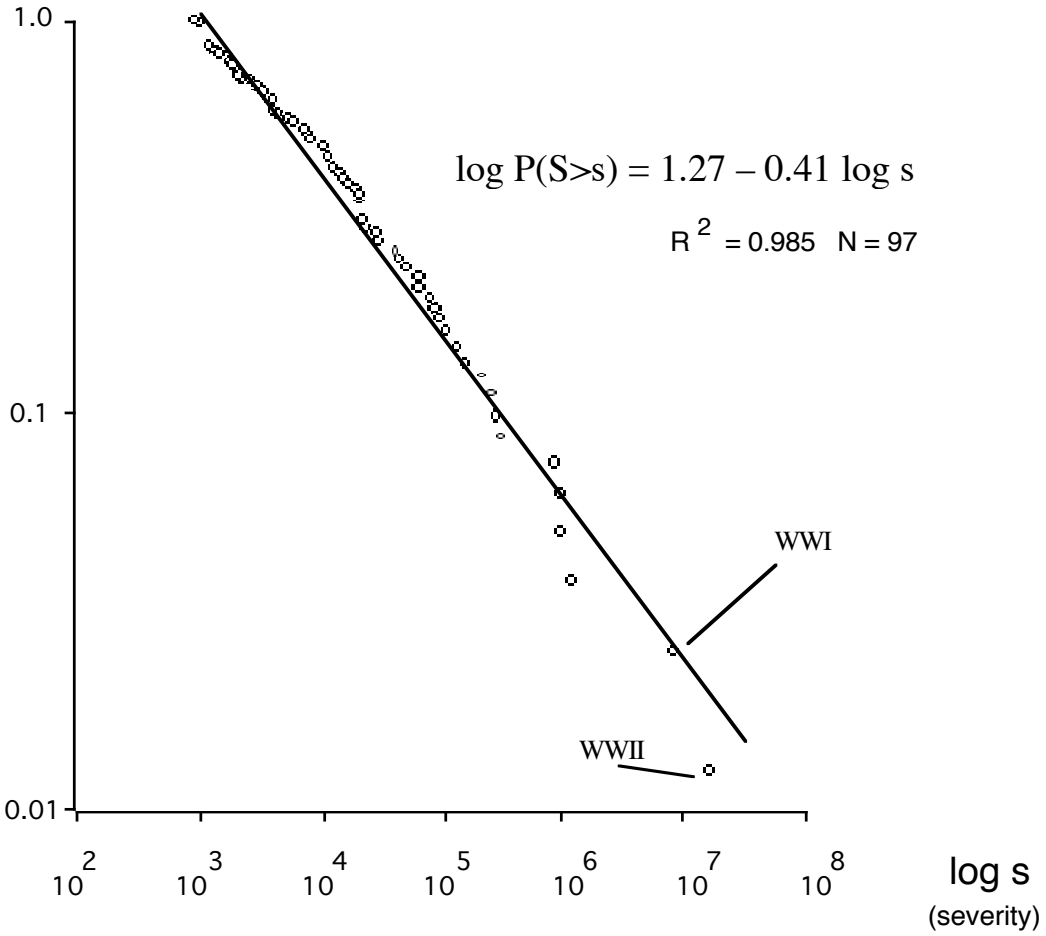
Treaty of Utrecht, 1713

K. Waltz (static equilibrium approach)

R. Gilpin (dynamic approach)

Cumulative log-log frequency plot, interstate wars 1820-1997

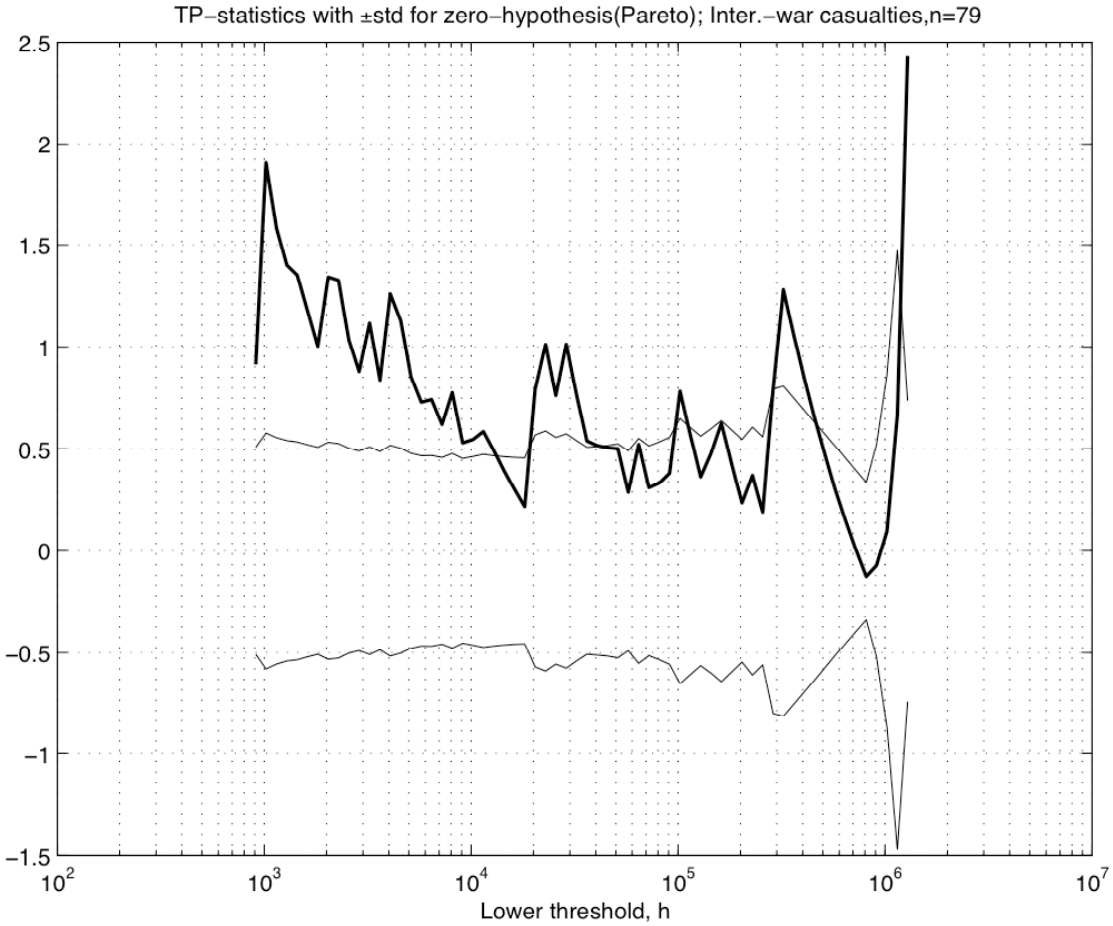
log P(S>s)
(cumulative frequency)



Data Source:
Correlates
of War
Project (COW)

See Cederman
APSR 2003

Interstate war casualties:
Test of upper tail as a function of lower threshold



Data:
COW

Analysis with
Pisarenko &
Sornette

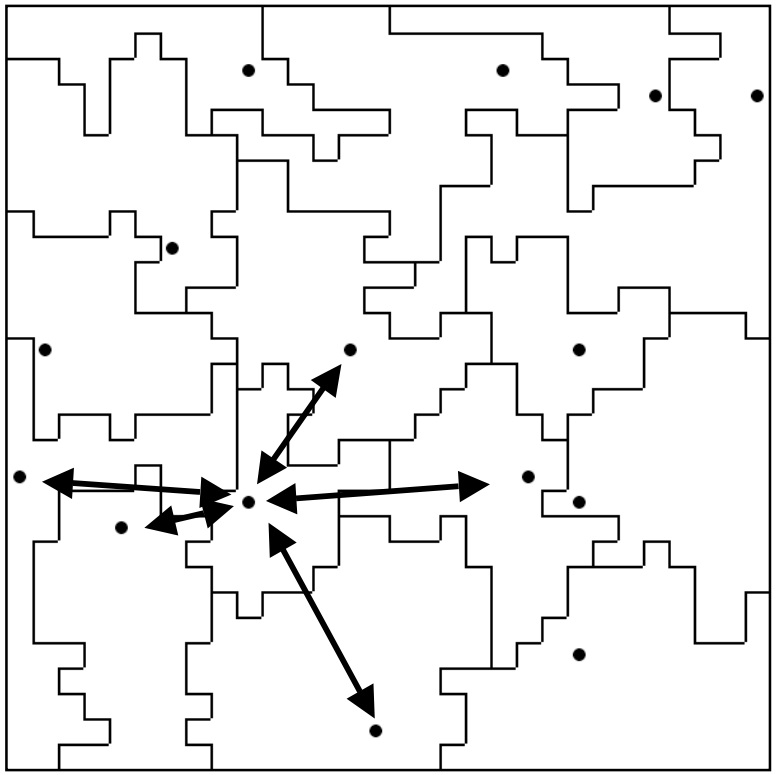
Europe in 1500

Europe in 1900

"States made war and war made the state" *Charles Tilly*

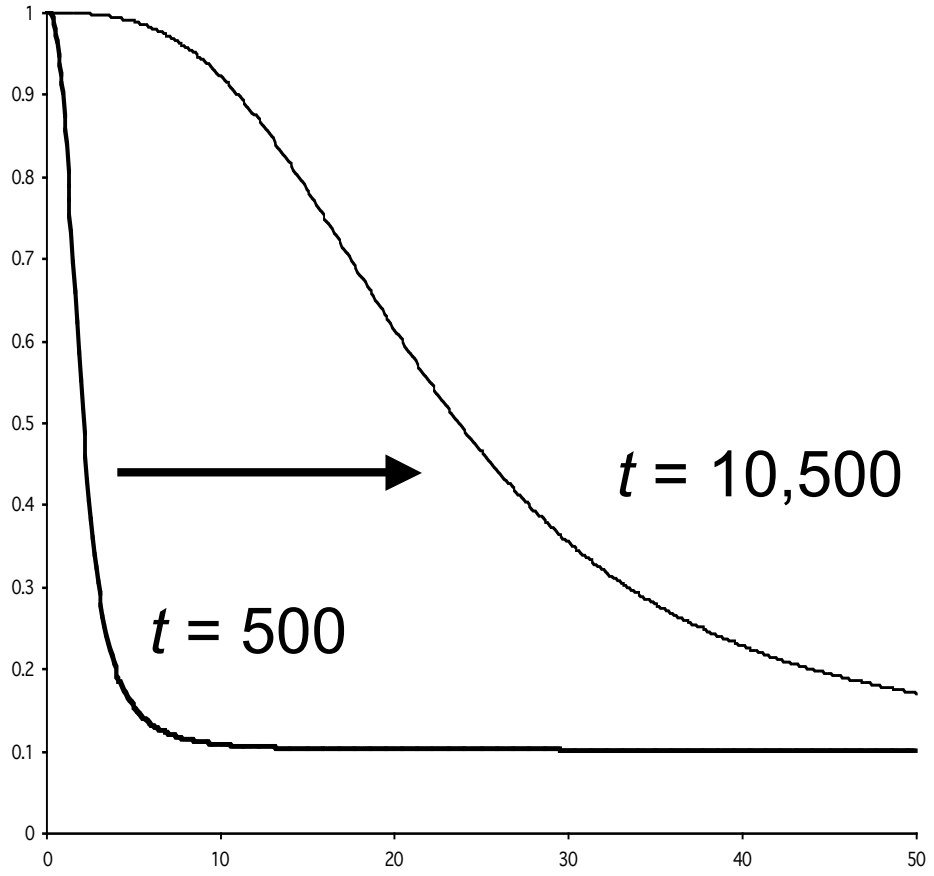
Geosim

- Geosim uses Repast, a Java toolkit
- States are hierarchical, bounded actors interacting in a dynamic network imposed on a grid
- *Emergent Actors in World Politics* (PUP 1997)



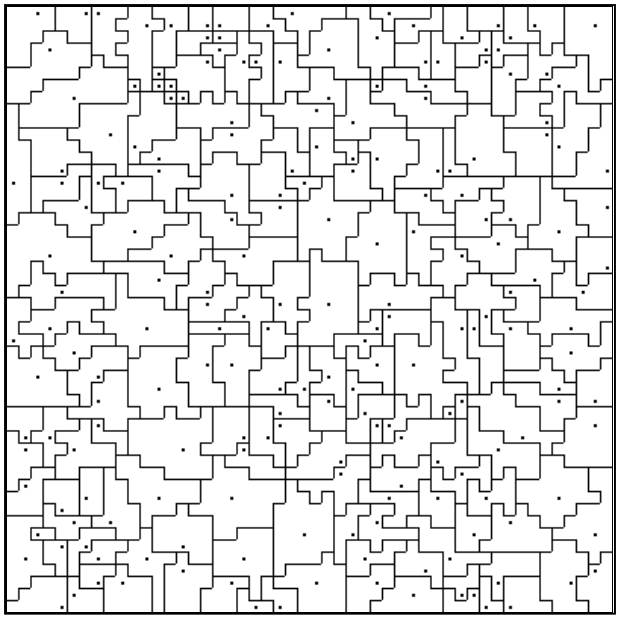
Technological change in terms of the loss-of-strength gradient

Degree of resource extraction and projection

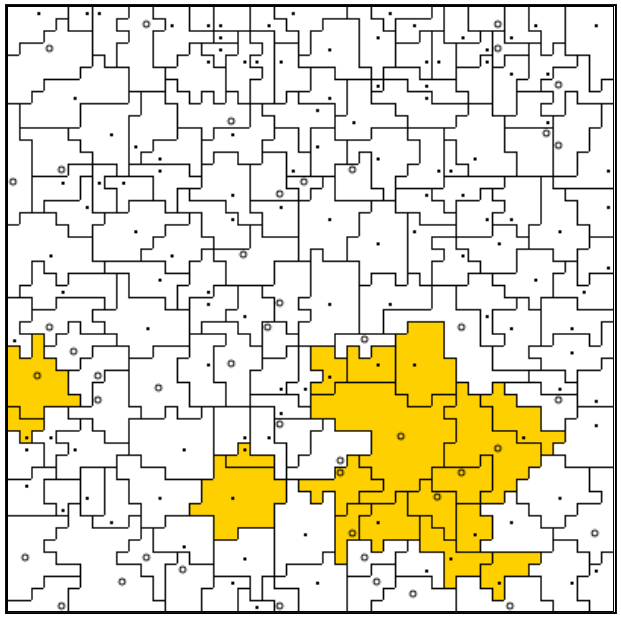


Distance from capital

Modified Geosim Model

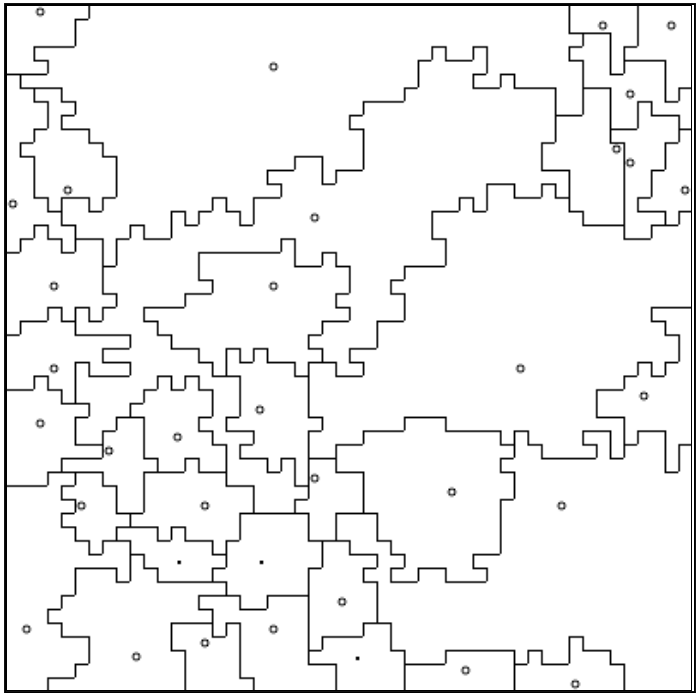


$t = 500$



$t = 3326$

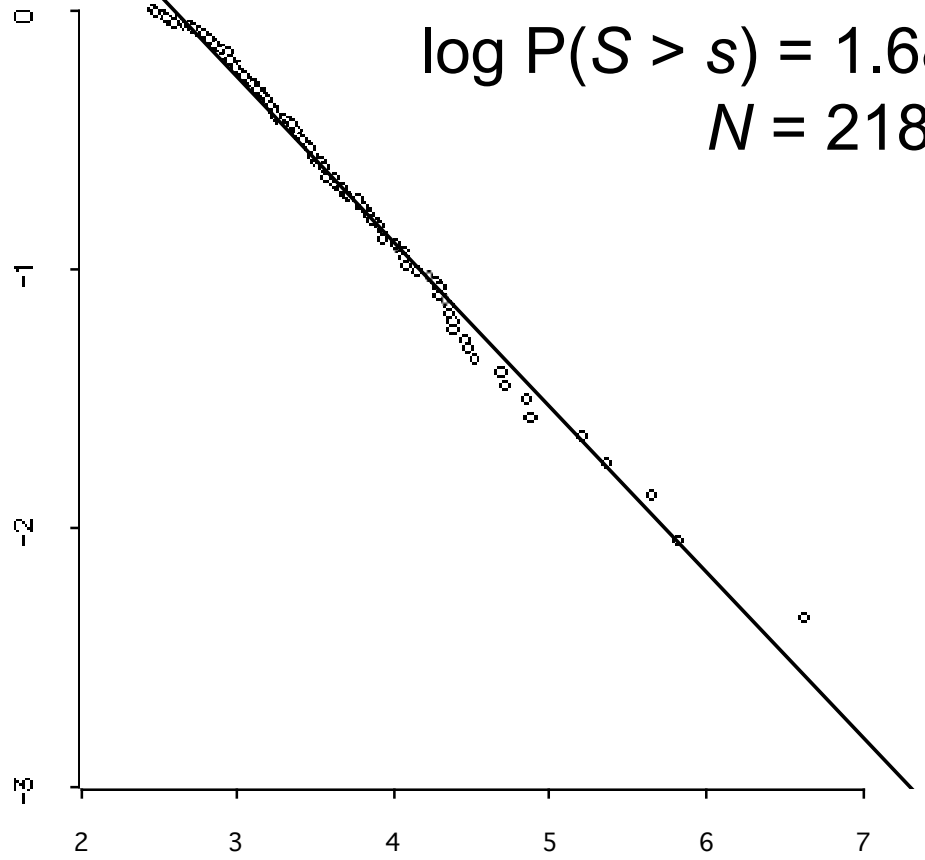
Final outcome



$t = 10{,}500$

Results: Simulated cumulative frequency distribution in the sample run

log P($S > s$)



log P($S > s$) = 1.68 – 0.64 log s

$N = 218$ $R^2 = 0.991$

log s

Conclusions from Geosim Model

- First macro model that generates power-law distributed wars
- Technological change + contextual activation
- Non-equilibrium perspective appropriate
- Gilpin rather than Waltz
- Path-dependence doesn't preclude regularities

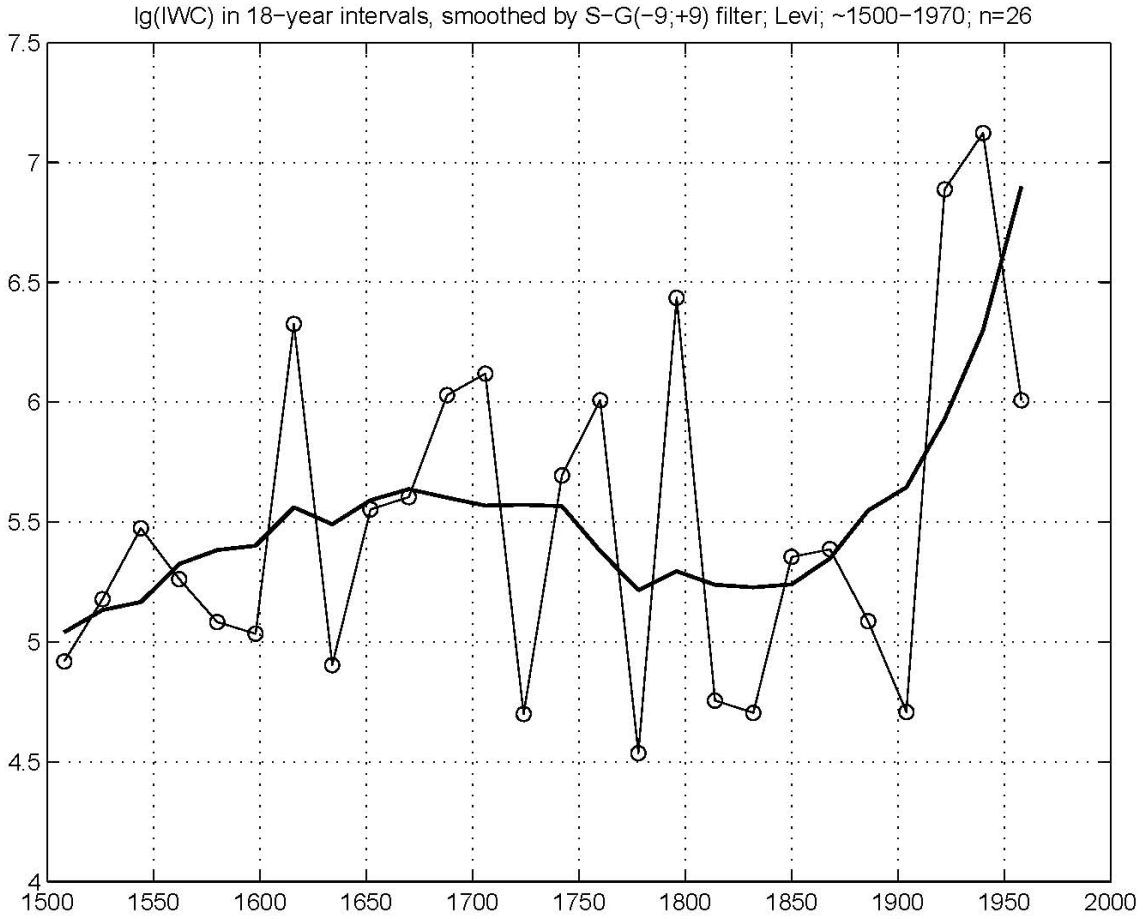
New evidence and future research

- Nationalism and war size
- Nationalism and state sizes
- Civil wars

Nationalism and warfare

The Battle of Valmy, 20 September 1792

Trends in war severity, 1500-1970

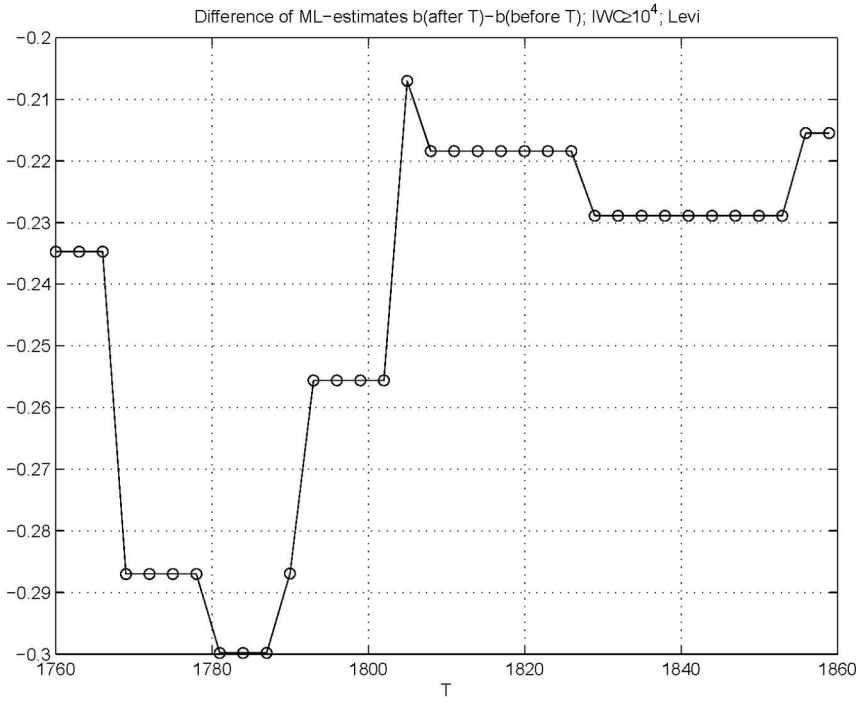


Data:
Levy 1983

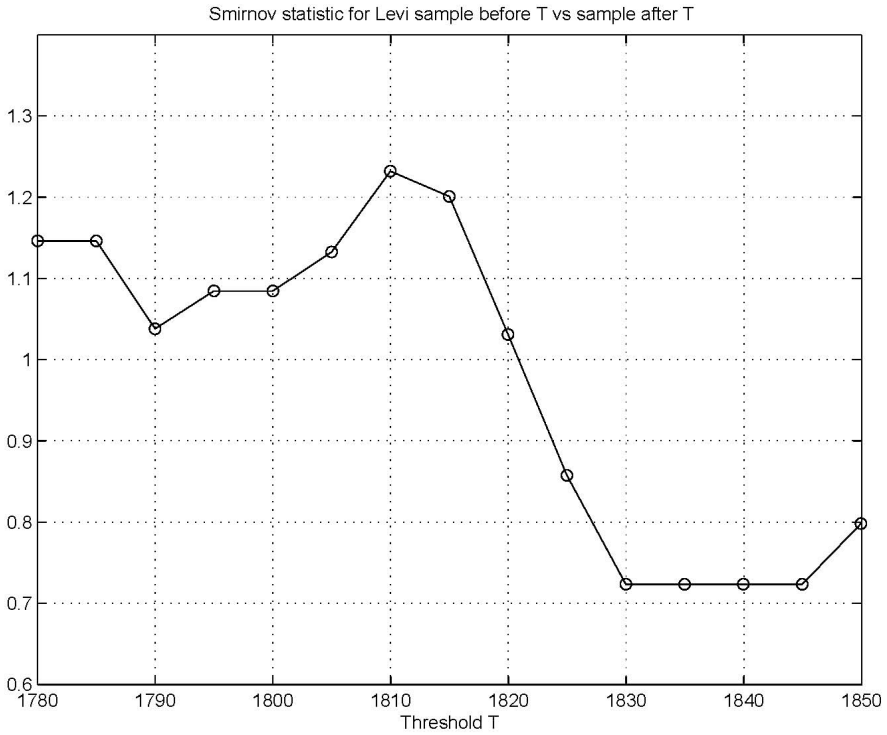
Analysis with
Pisarenko &
Sornette

Are there two regimes?

Partitioned MLE



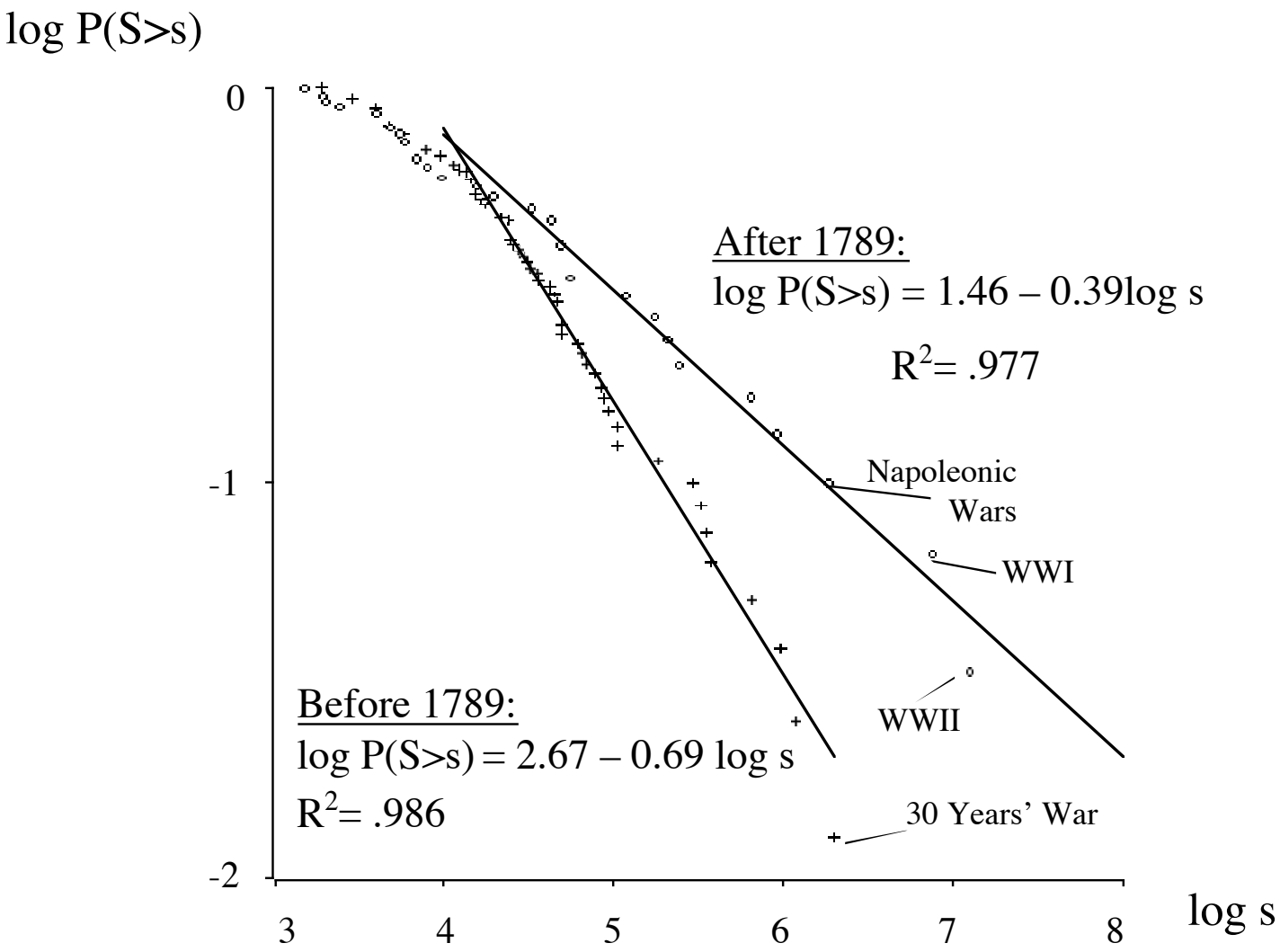
Smirnov statistic for Levy sa



Data: Levy 1983

Analysis with Pisarenko & Sornette

Warfare before and after the French Revolution



Data: Levy 1983

Nationalism-based explanati0ns

H_1: Nationalism => Power imbalance => War

<u>Mechanisms:</u>

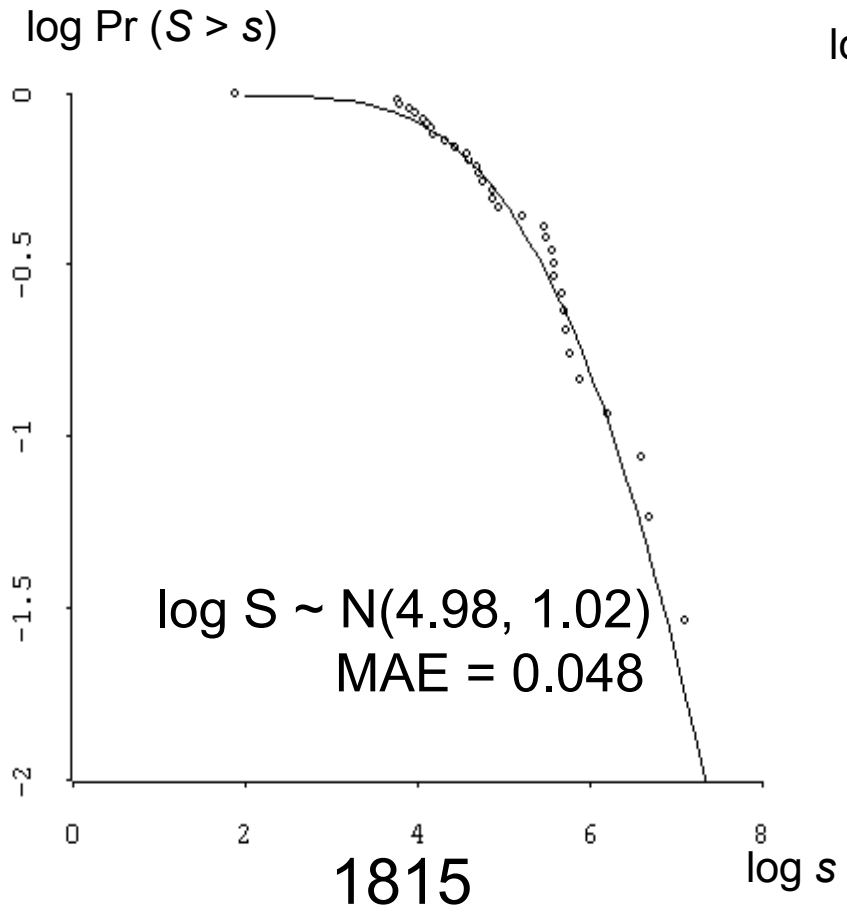
H_2: Nationalist behavior more risk-willing

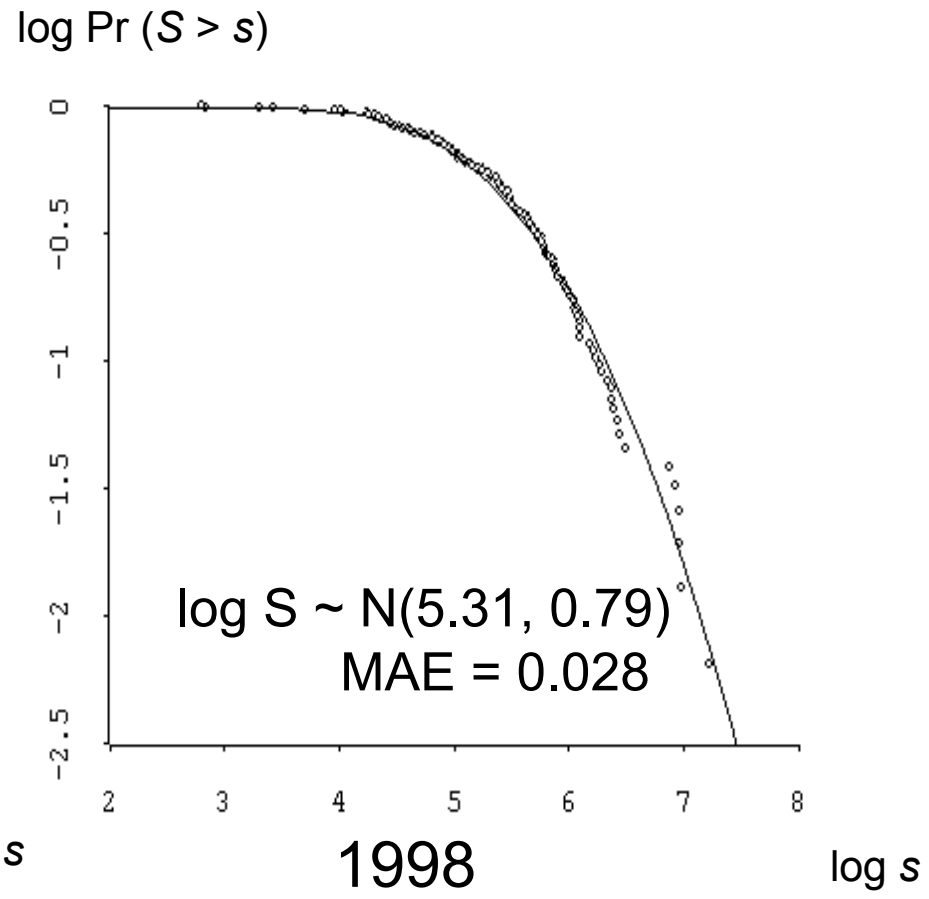
H_3: Nationalist resource extraction more effective

H_4: Nationalist mobilization at uneven speeds

~~H_5: Nationalist secession and unification~~

Territorial state sizes

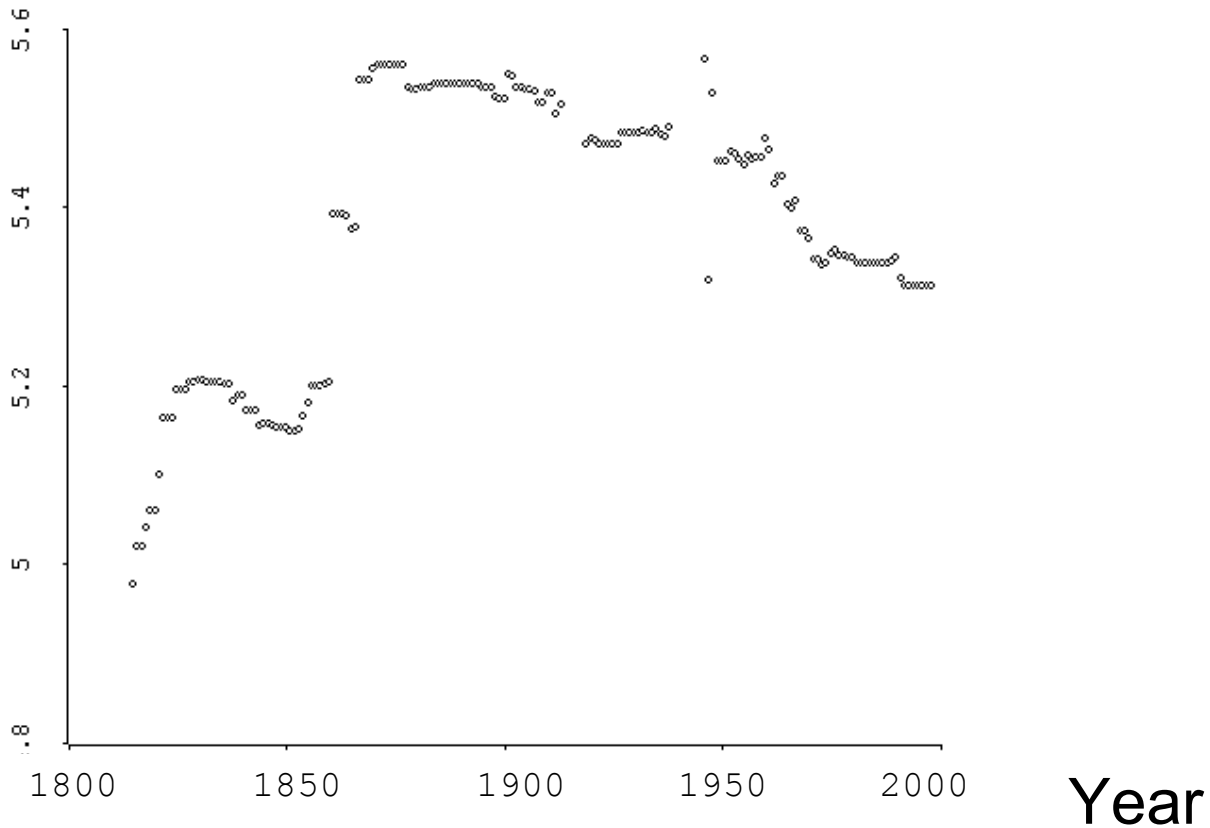




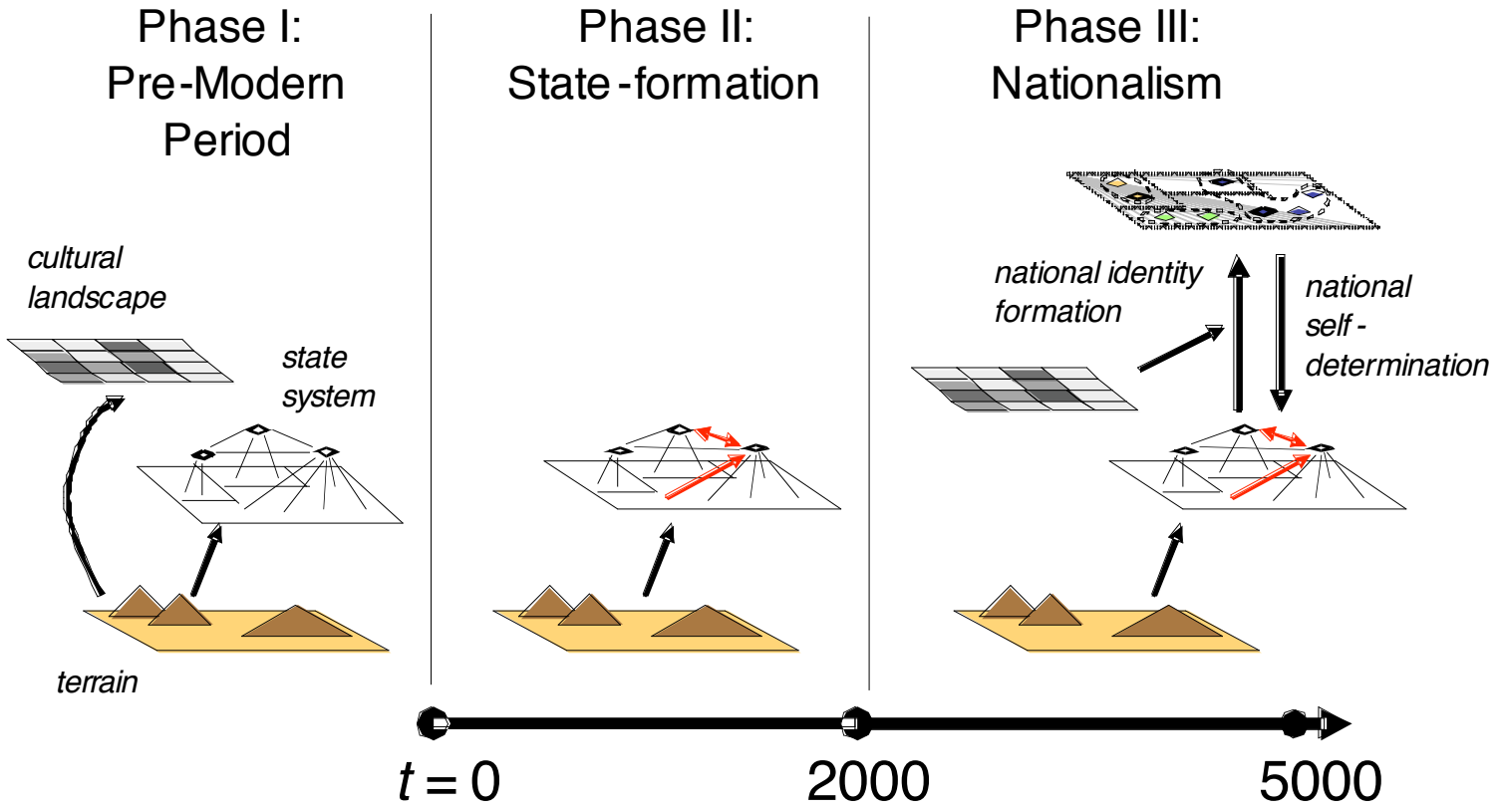
Data: Lake et al.

Estimated means, 1815-1998

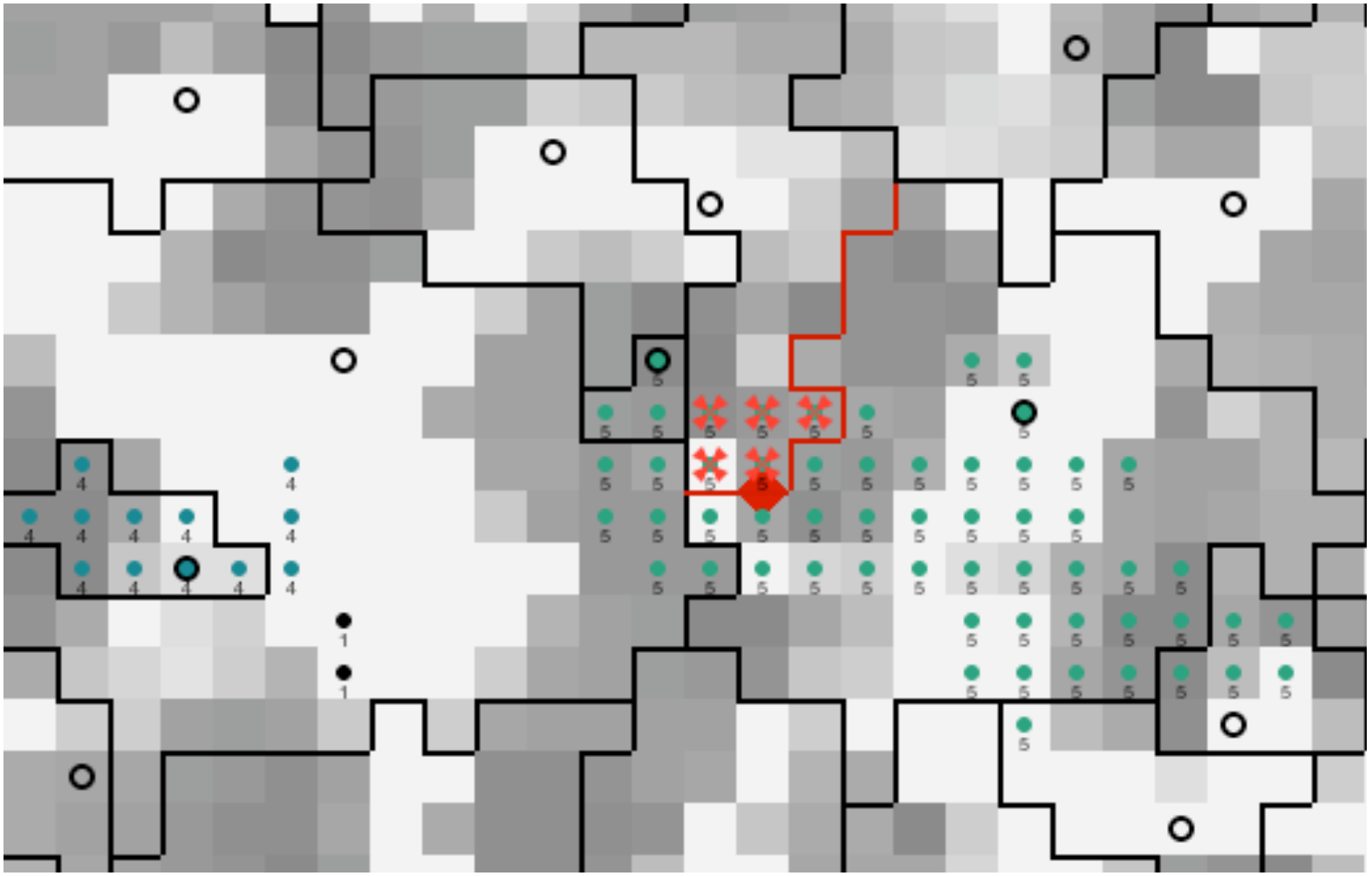
μ



Nested processes

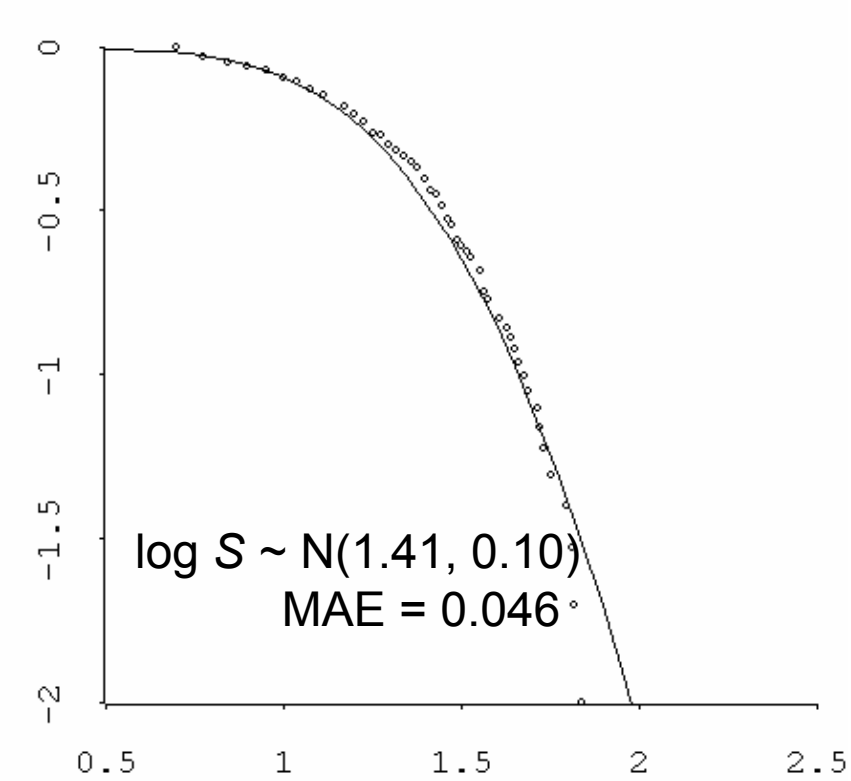


Geosim 5 Model



Simulated state sizes fitted by log-normal curve

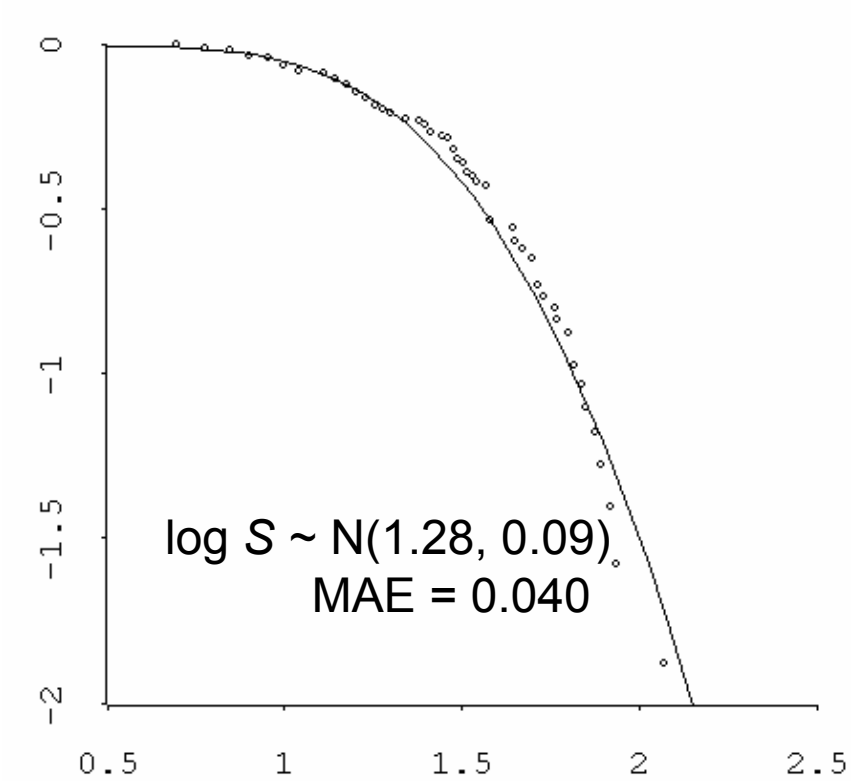
log Pr(*S*>*s*)



t = 2000

log *s*

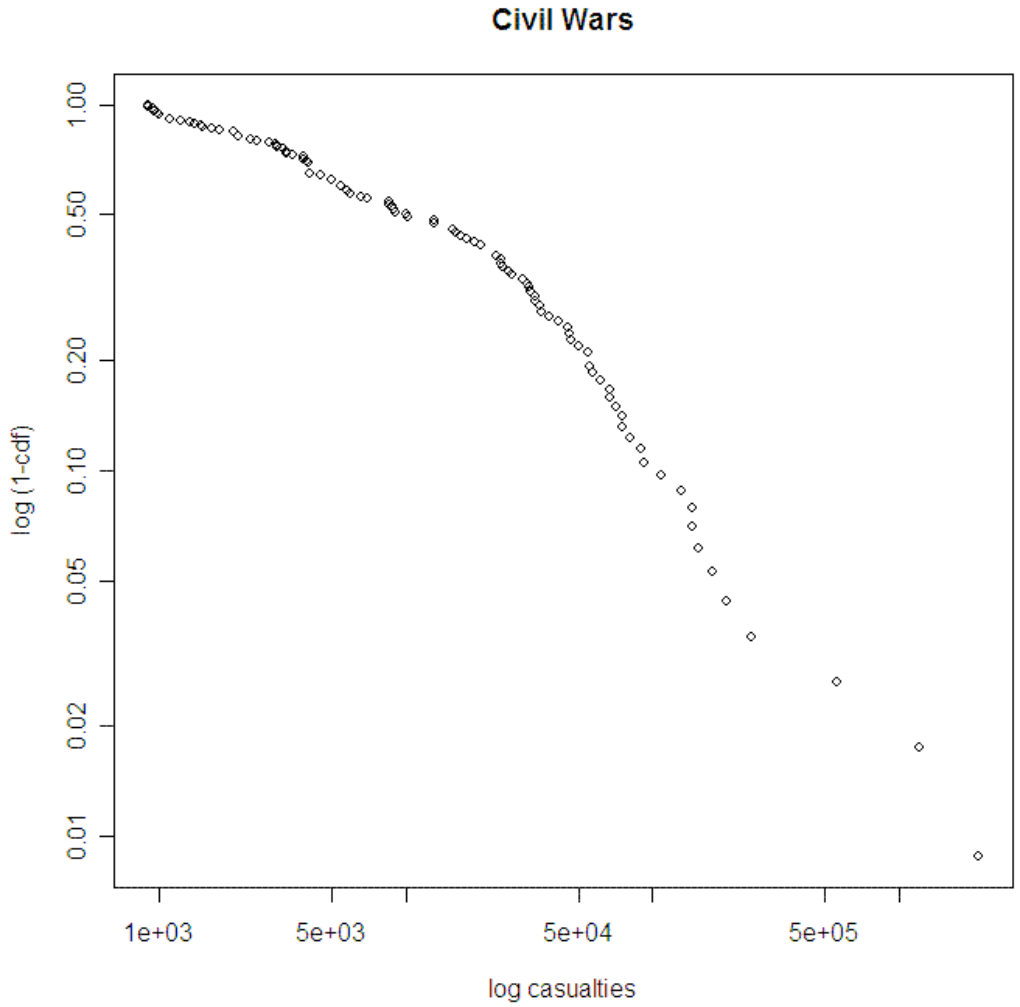
log Pr(*S*>*s*)



t = 5000

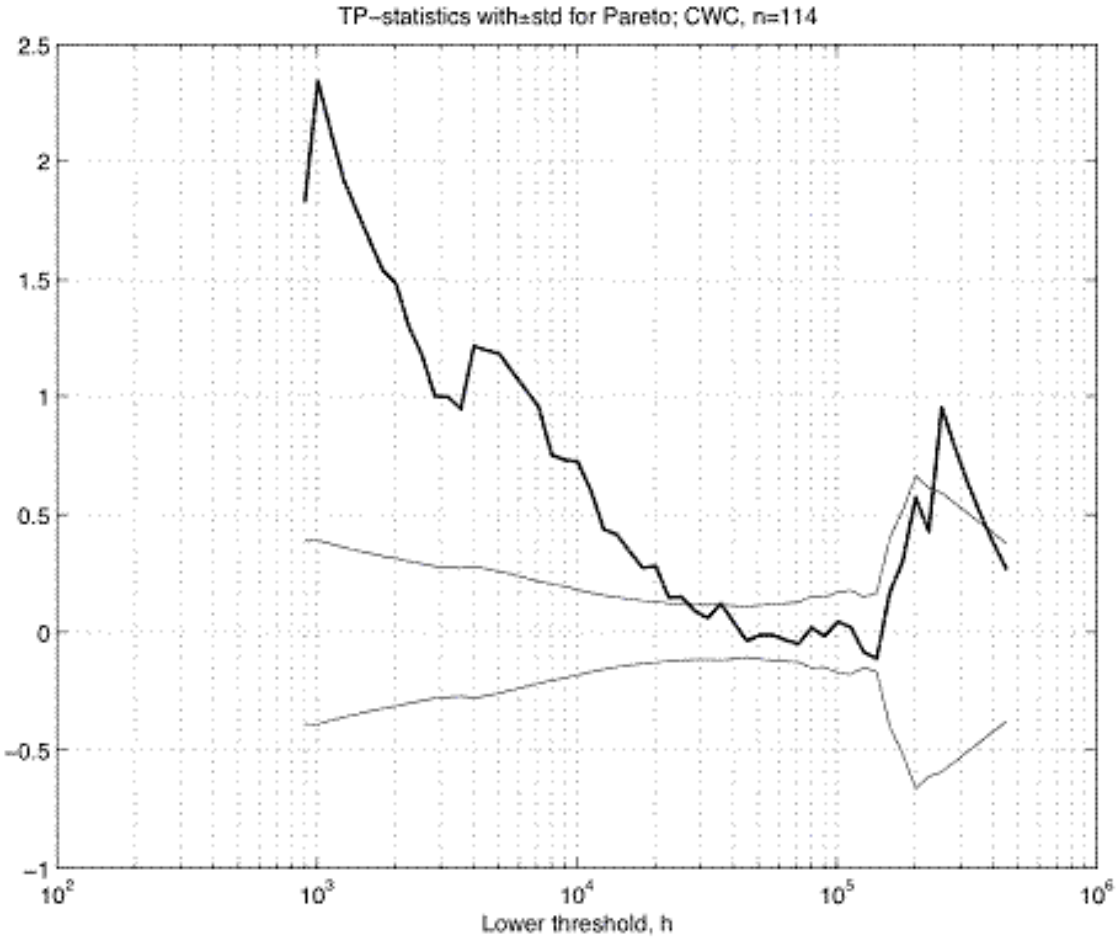
log *s*

Civil war casualties



Source:
Lacina 2006

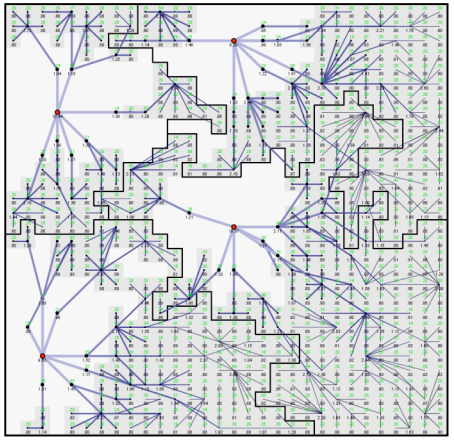
Civil war casualties:
Test of upper tail as a function of lower threshold



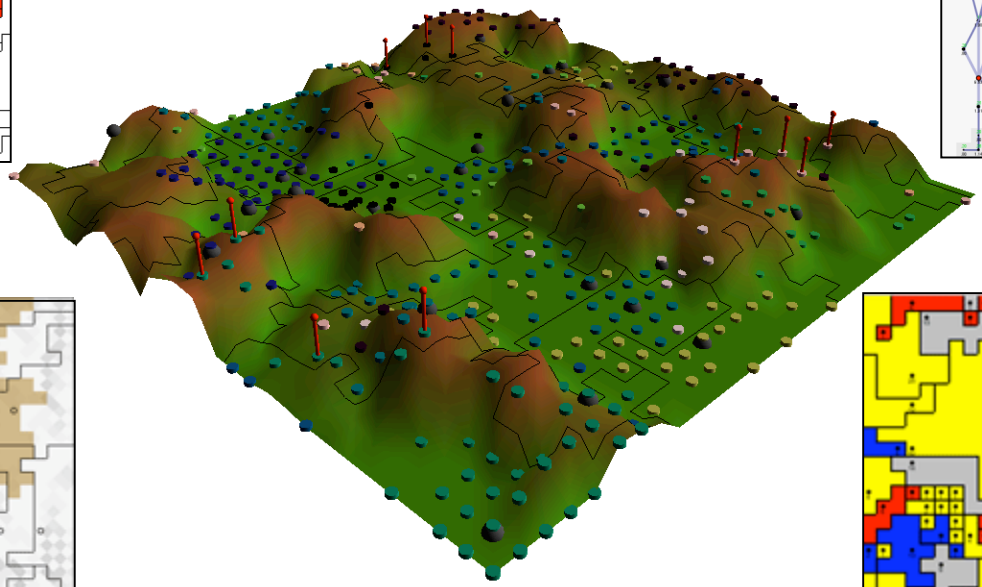
Analysis with Pisarenko & Sornette

Exploring geopolitics using agent-based modeling

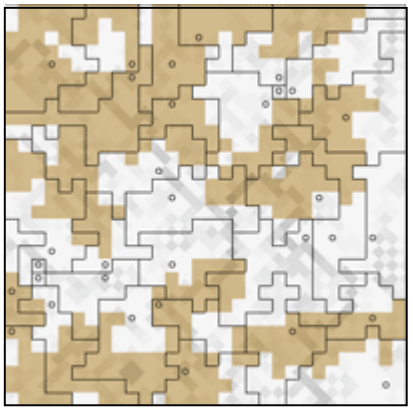
GeoSim 0



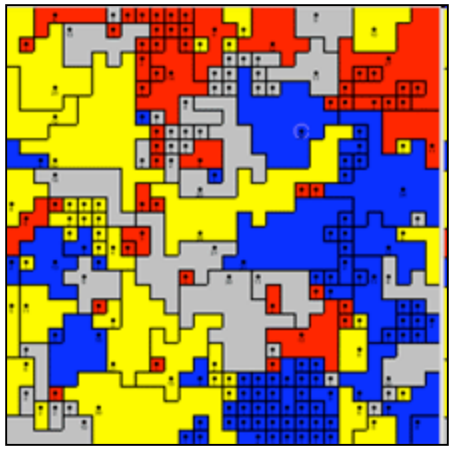
OrgForms



GeoSim 5



GeoSim 4



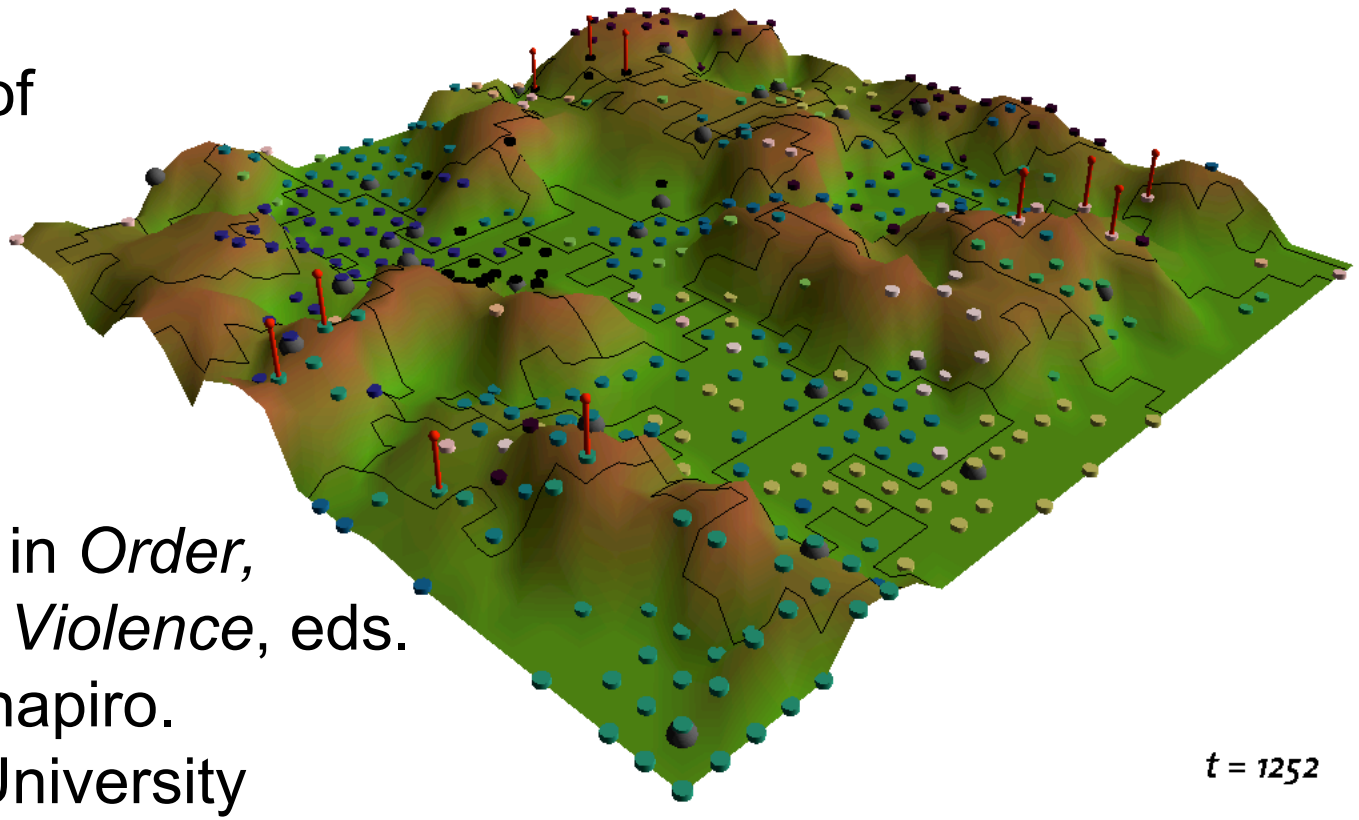
GeoContest

Toward more realistic models of civil wars

- Our strategy:
  - Step I: extending Geosim framework
  - Step II: conducting empirical research
  - Step III: back to computational modeling

Step I: Nationalist insurgency model

Use agent-based modeling to articulate identity-based mechanisms of insurgency



Forthcoming in *Order, Conflict, and Violence*, eds. Kalyvas & Shapiro. Cambridge University Press.

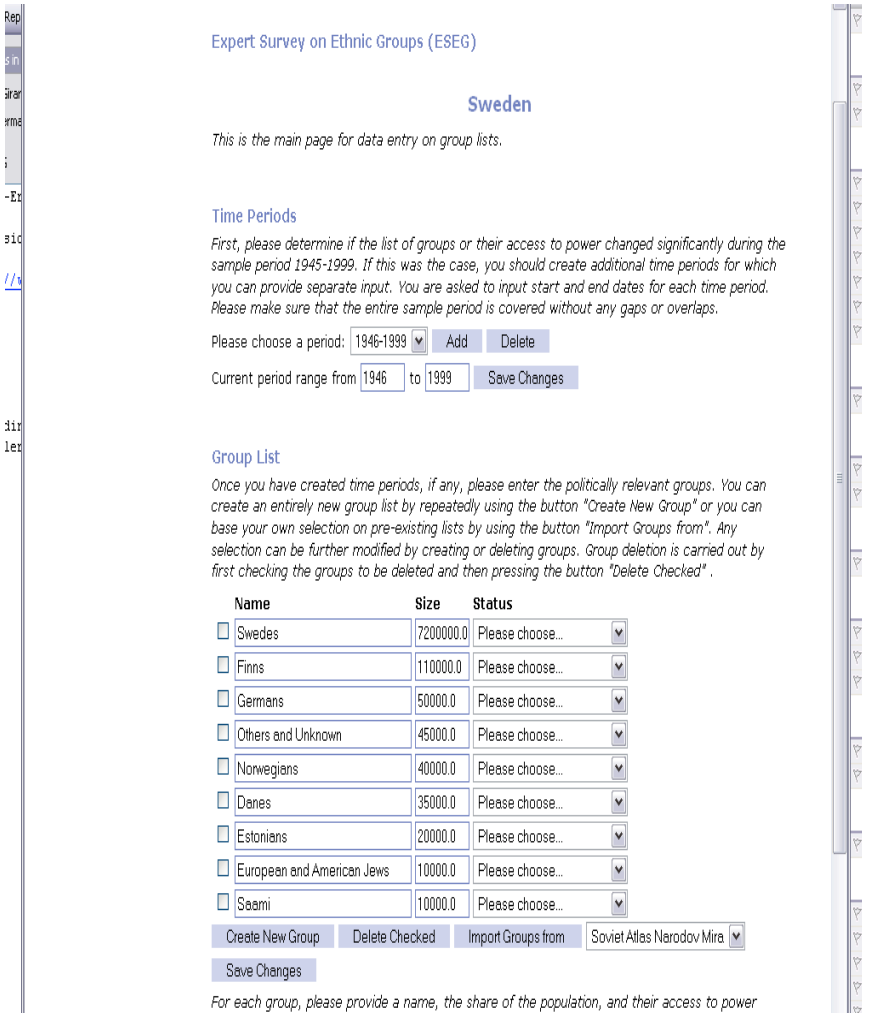
Step II: GREG Geo-Referencing of Ethnic Groups

- Scanning and geo-coding ethnic groups
- Polygon representation
- Based on *Atlas Narodov Mira* (1964)

Step II: ESEG Expert Survey of Ethnic Groups

Collaboration with Andreas Wimmer and Brian Min (UCLA)

Web-based interface in order to expand coding of politically relevant ethnic groups and their power access to the rest of the world with the help of area experts



Step III: GROWLab