

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

INTERNATIONAL CONFLICT RESEARCH

Toward a non-equilibrium approach to political violence

Lars-Erik Cederman

ETH Zürich

lcederman@ethz.ch

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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

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Analytical



Synthetic approach

Equilibrium



Non-equilibrium theory

Nomothetic



Generative method

Variable-based

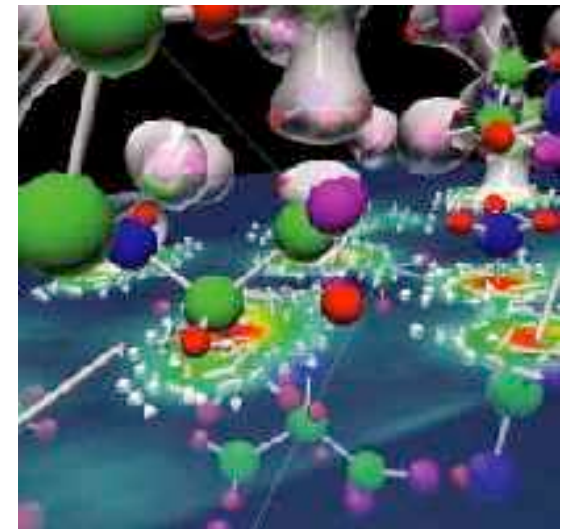
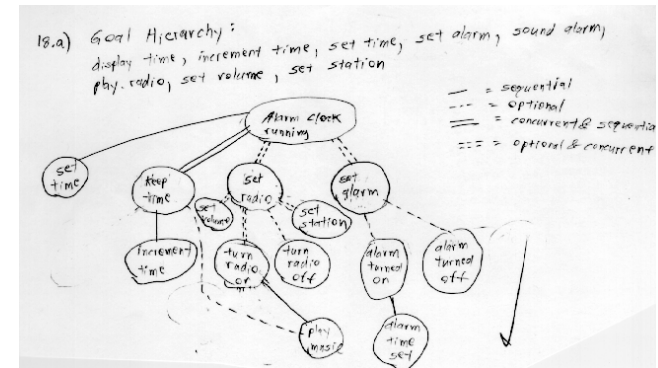


Configurative ontology

Analytical Synthetic approach

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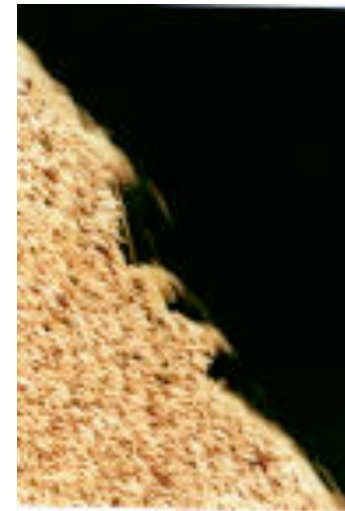
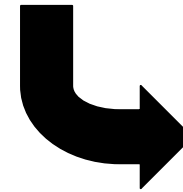
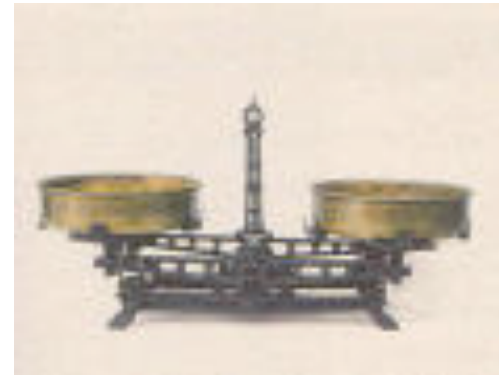
- Hope to solve problems through strategy of “divide and conquer”
- Need to make *ceteris paribus* assumption
- **But** in complex systems this assumption breaks down
- Herbert Simon: Complex systems are composed of large numbers of parts that interact in a non-linear fashion
- Need to study interactions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



Equilibrium Non-equilibrium theory

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- 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

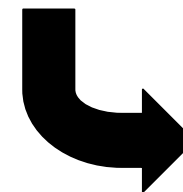
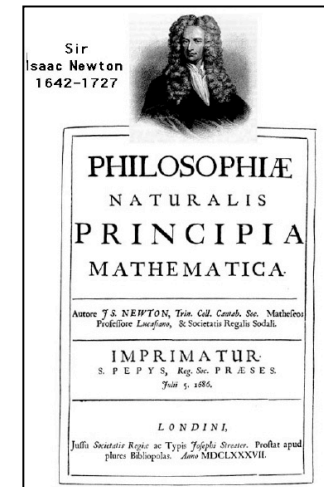


Example: Avalanches in
rice pile

Nomothetic Generative method

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- 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

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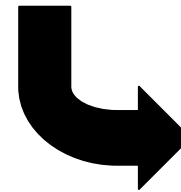
- Conventional models are variable-based
- Social entities are assumed implicitly
- **But** variables say little about social forms
- A *social form* is a configuration of social interactions and actors together with the structures in which they are embedded
- Statistical physics and computational modeling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



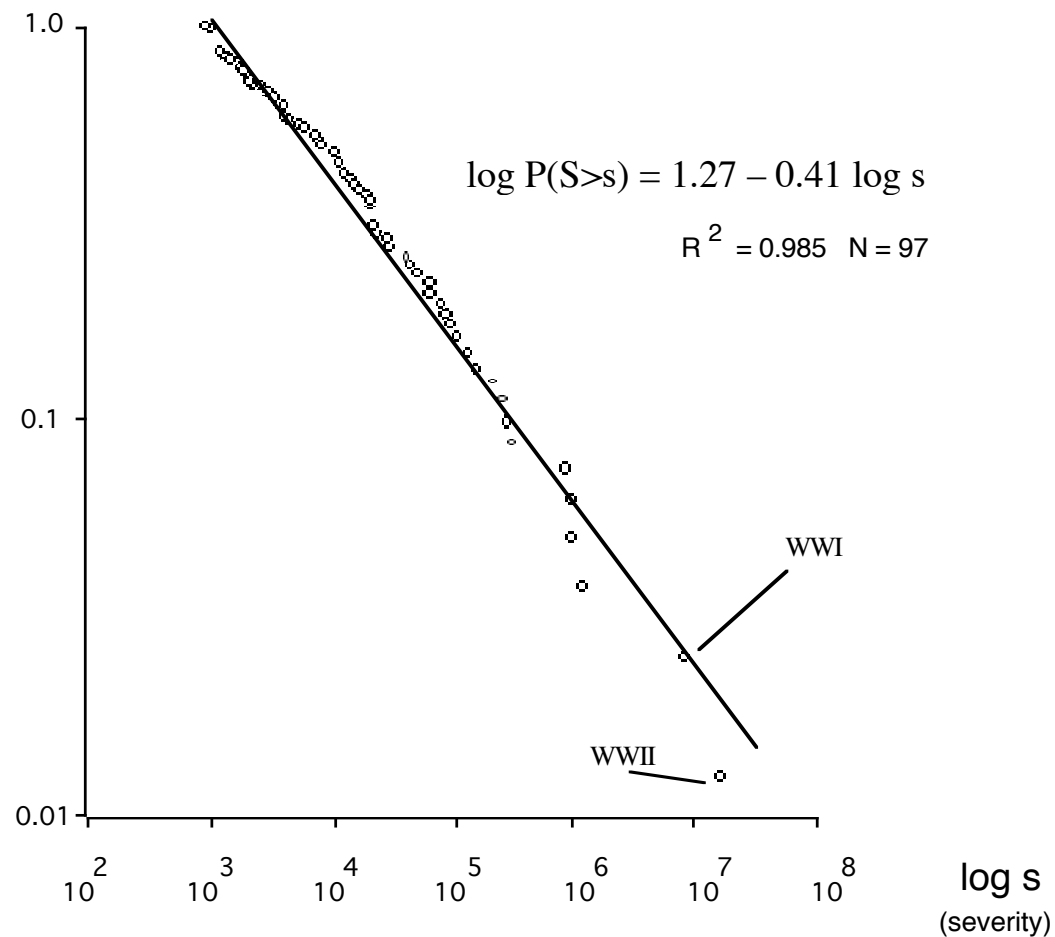
*R. Gilpin
(dynamic
approach)*



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

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$\log P(S>s)$
(cumulative frequency)

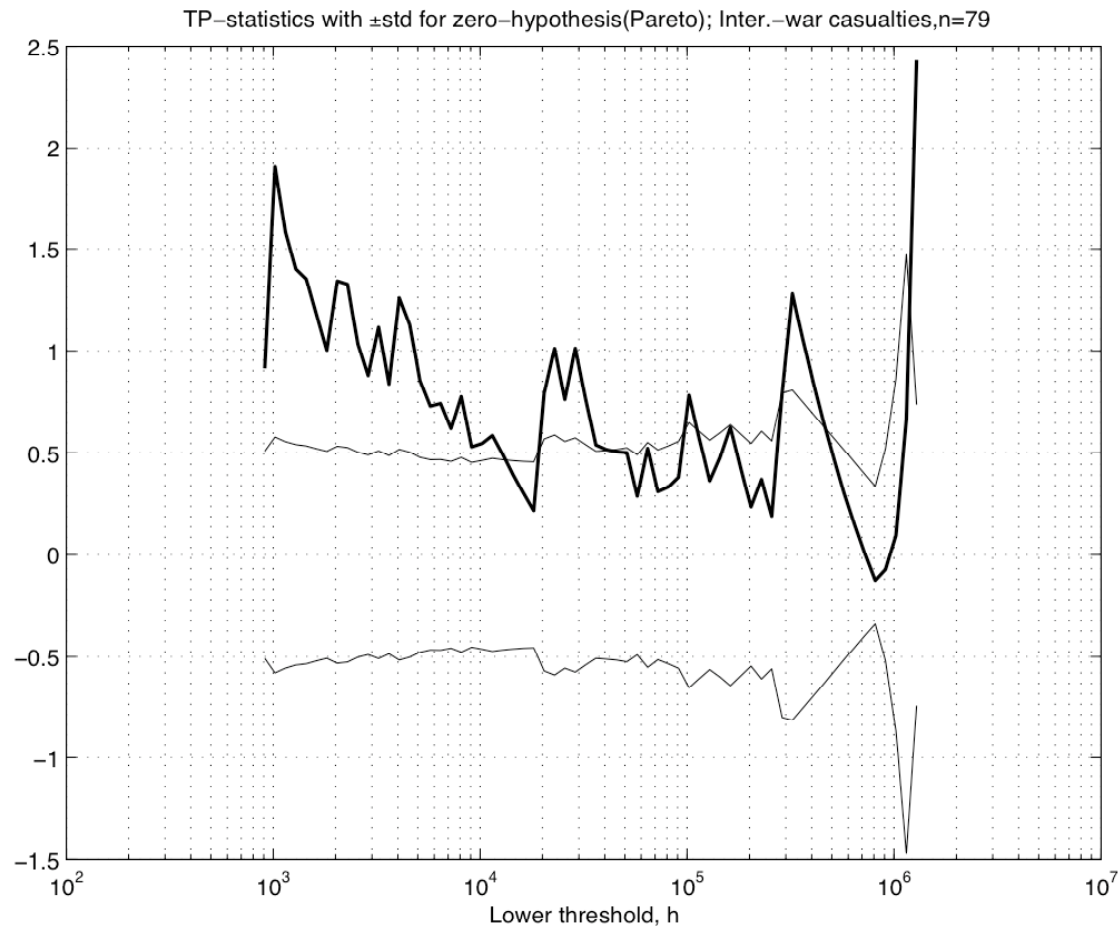


Data Source:
Correlates
of War
Project (COW)

See Cederman
APSR 2003

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

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Data:
COW

Analysis with
Pisarenko &
Sornette

Europe in 1500



Europe in 1900



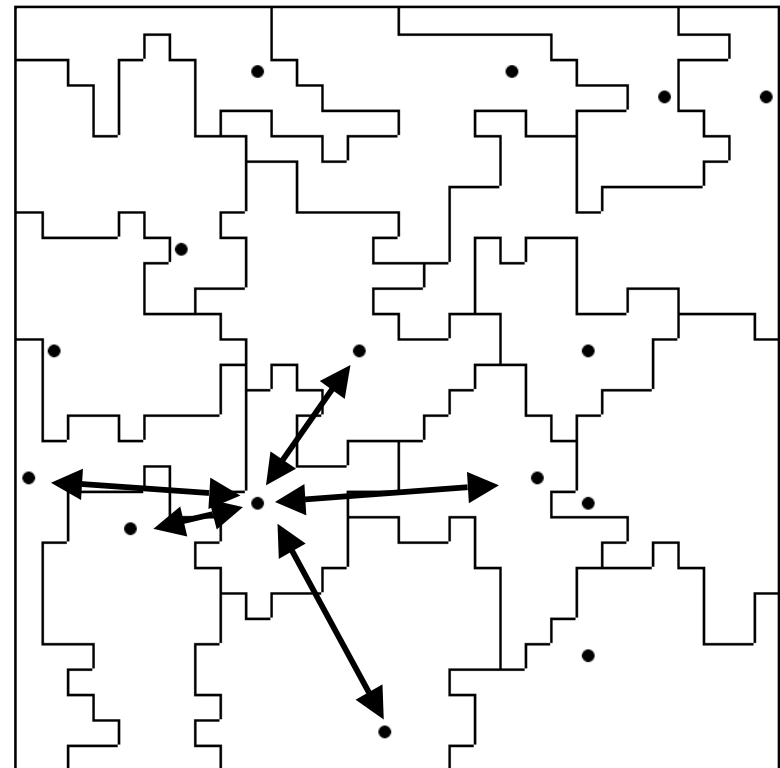
“States made war and war made the state” *Charles Tilly*



Geosim

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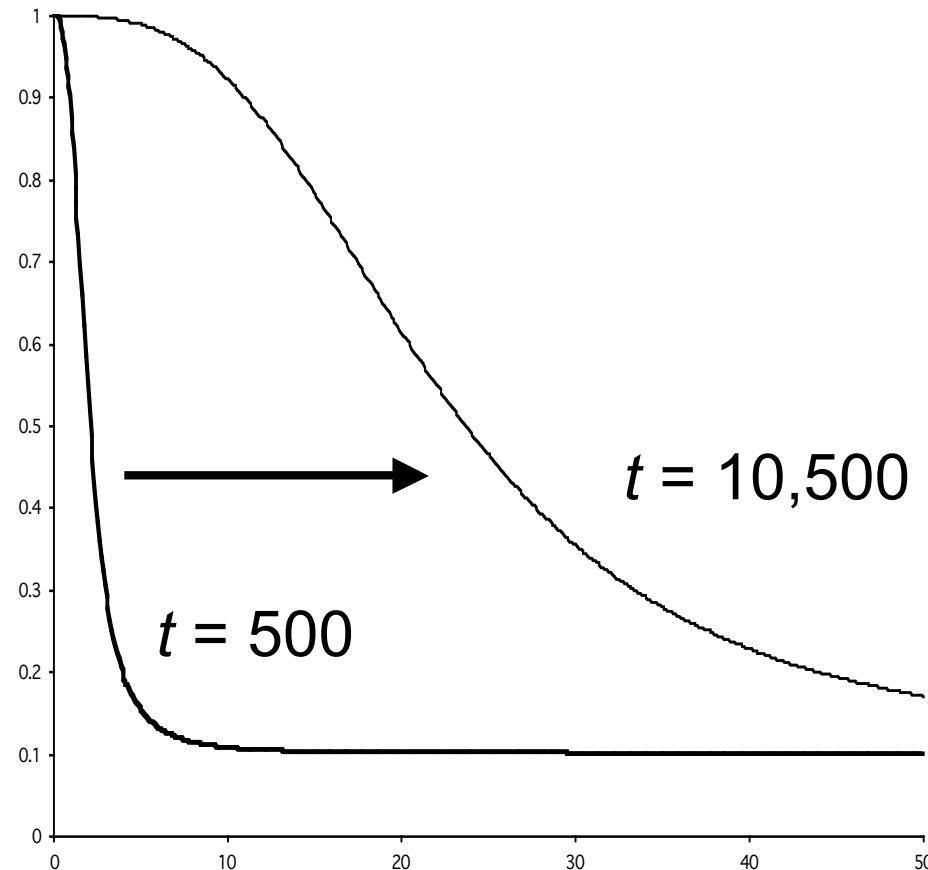
- Geosim uses Repast, a Java toolkit
- States are hierarchical, bounded actors interacting in a dynamic network imposed on a grid
- *Emergent Actors in World Politics* (PUP 1997)



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

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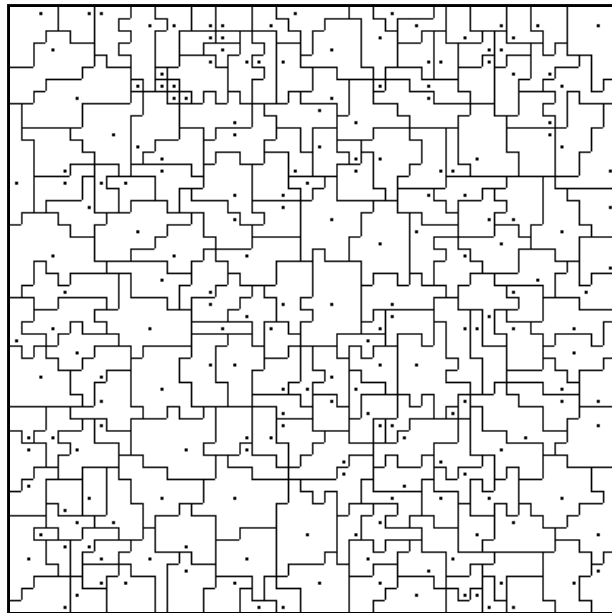
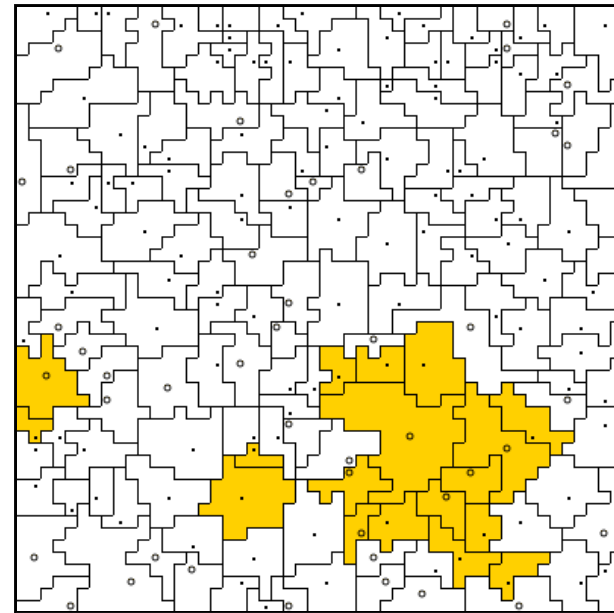
Degree of resource
extraction and projection



Distance from
capital

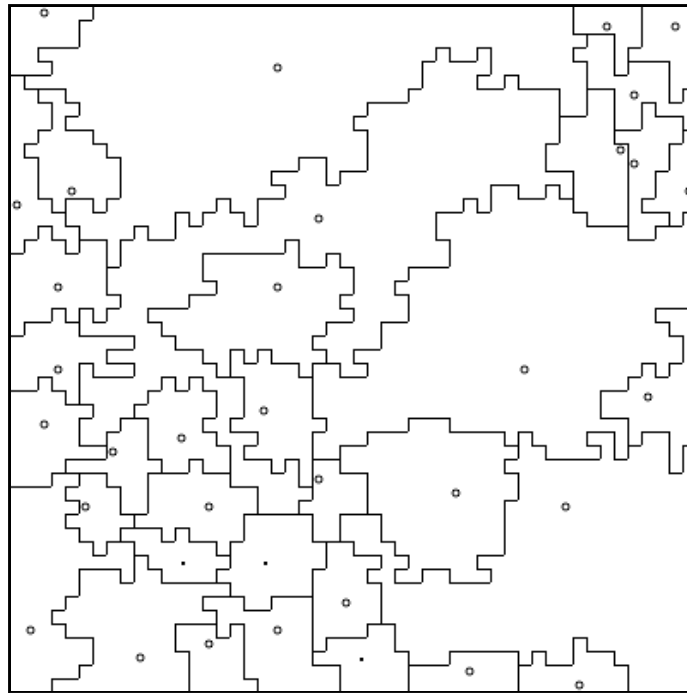
Modified Geosim Model

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 $t = 500$  $t = 3326$

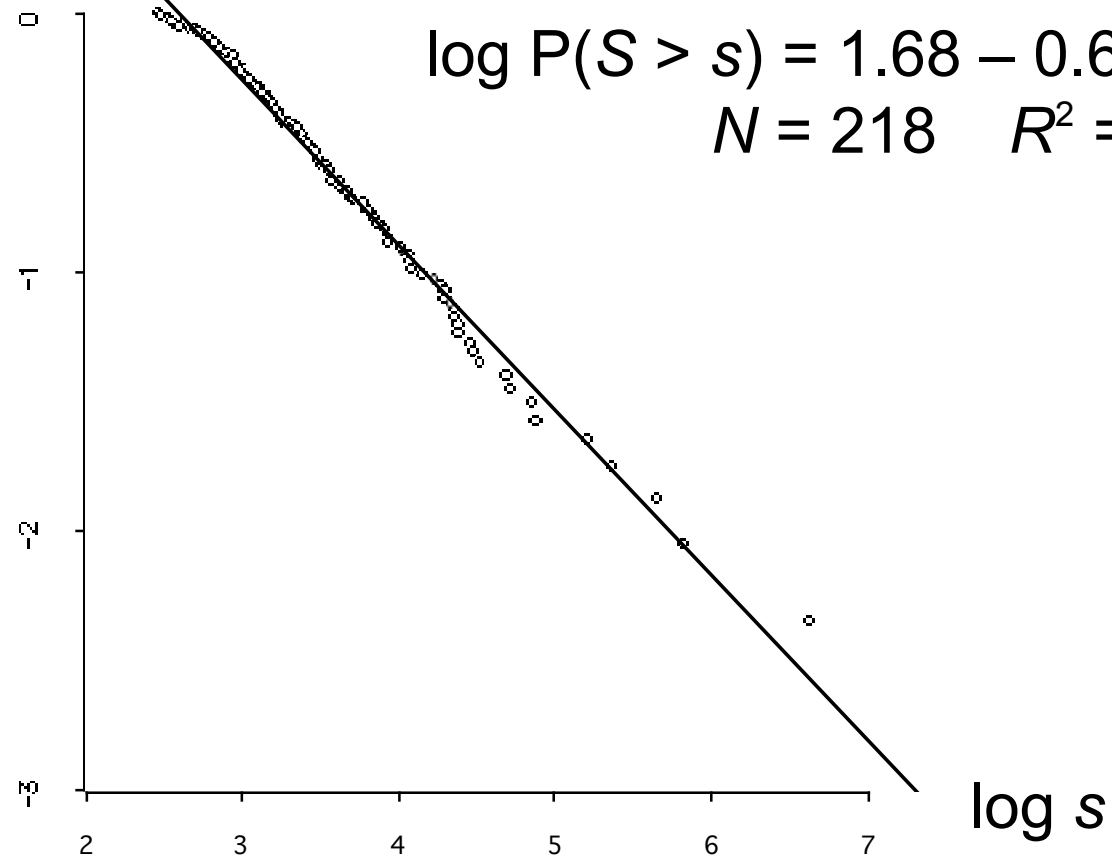
Final outcome

17

 $t = 10,500$

Results: Simulated cumulative frequency distribution in the sample run

18

 $\log P(S > s)$ 

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

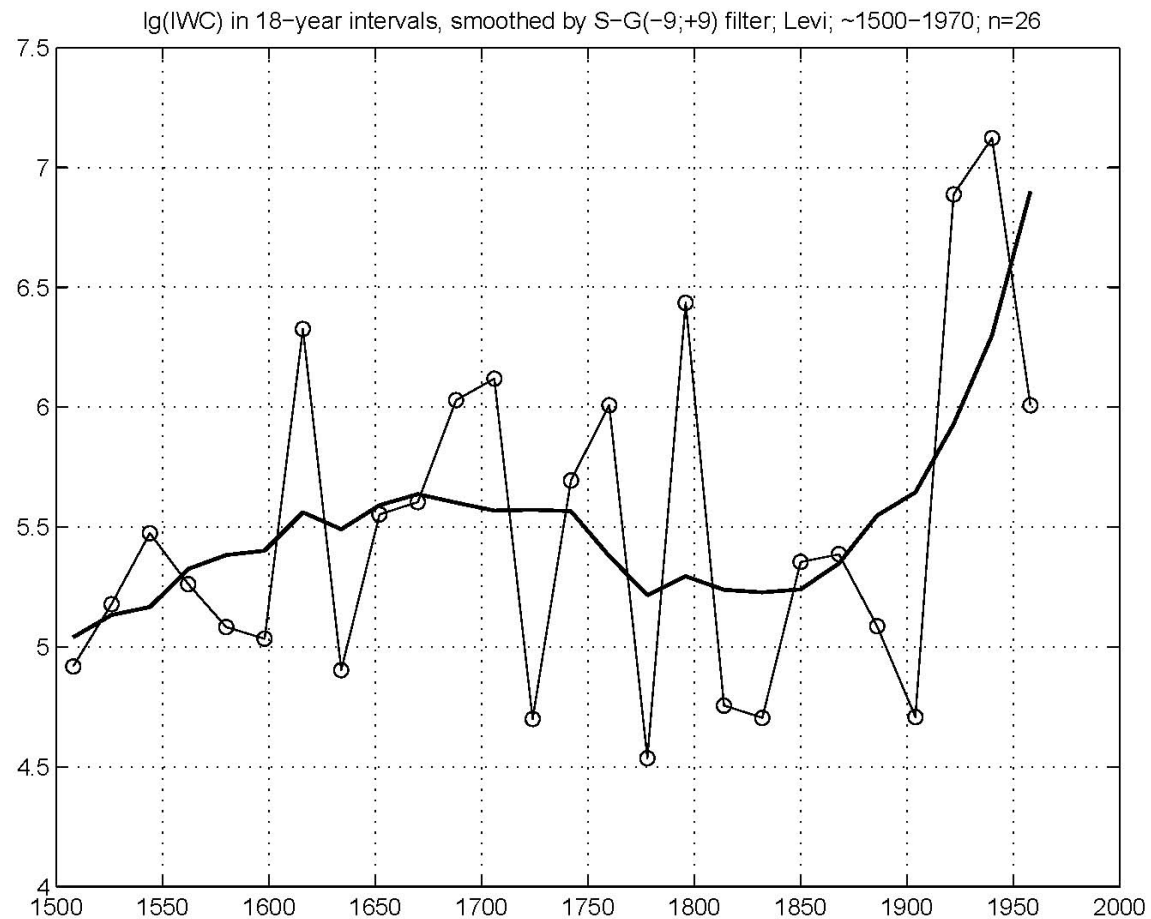
21



The Battle of Valmy, 20 September 1792

Trends in war severity, 1500-1970

22



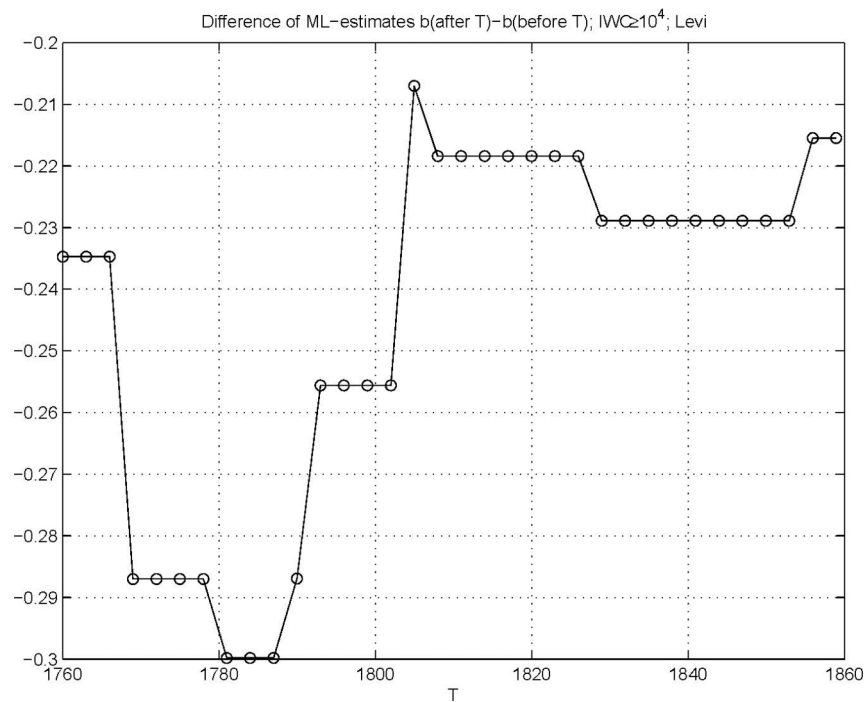
Data:
Levy 1983

Analysis with
Pisarenko &
Sornette

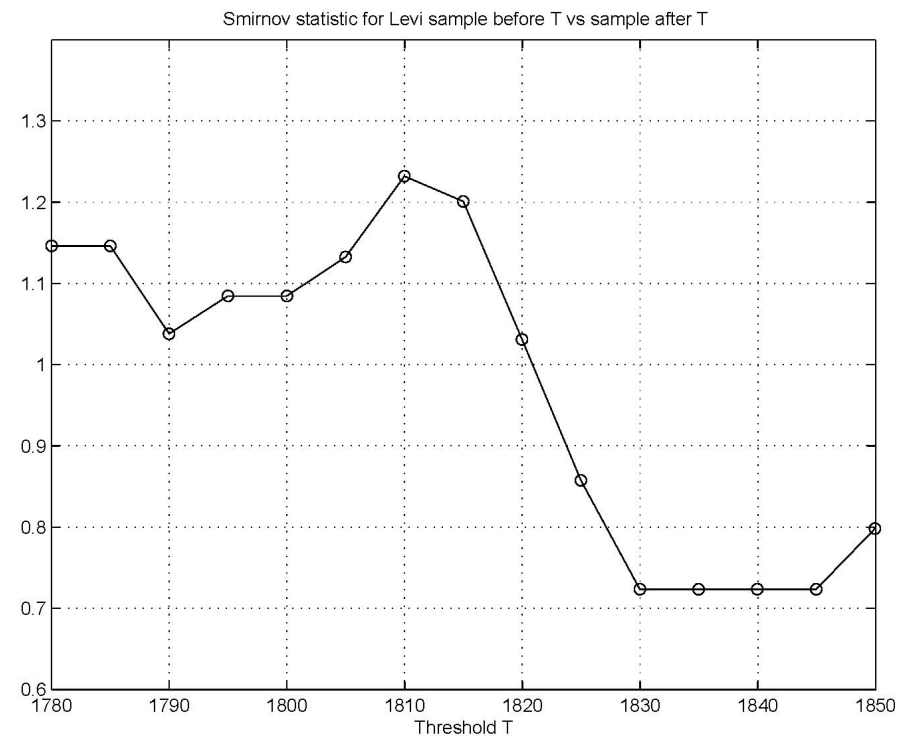
Are there two regimes?

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Partitioned MLE



Smirnov statistic for Levi sample

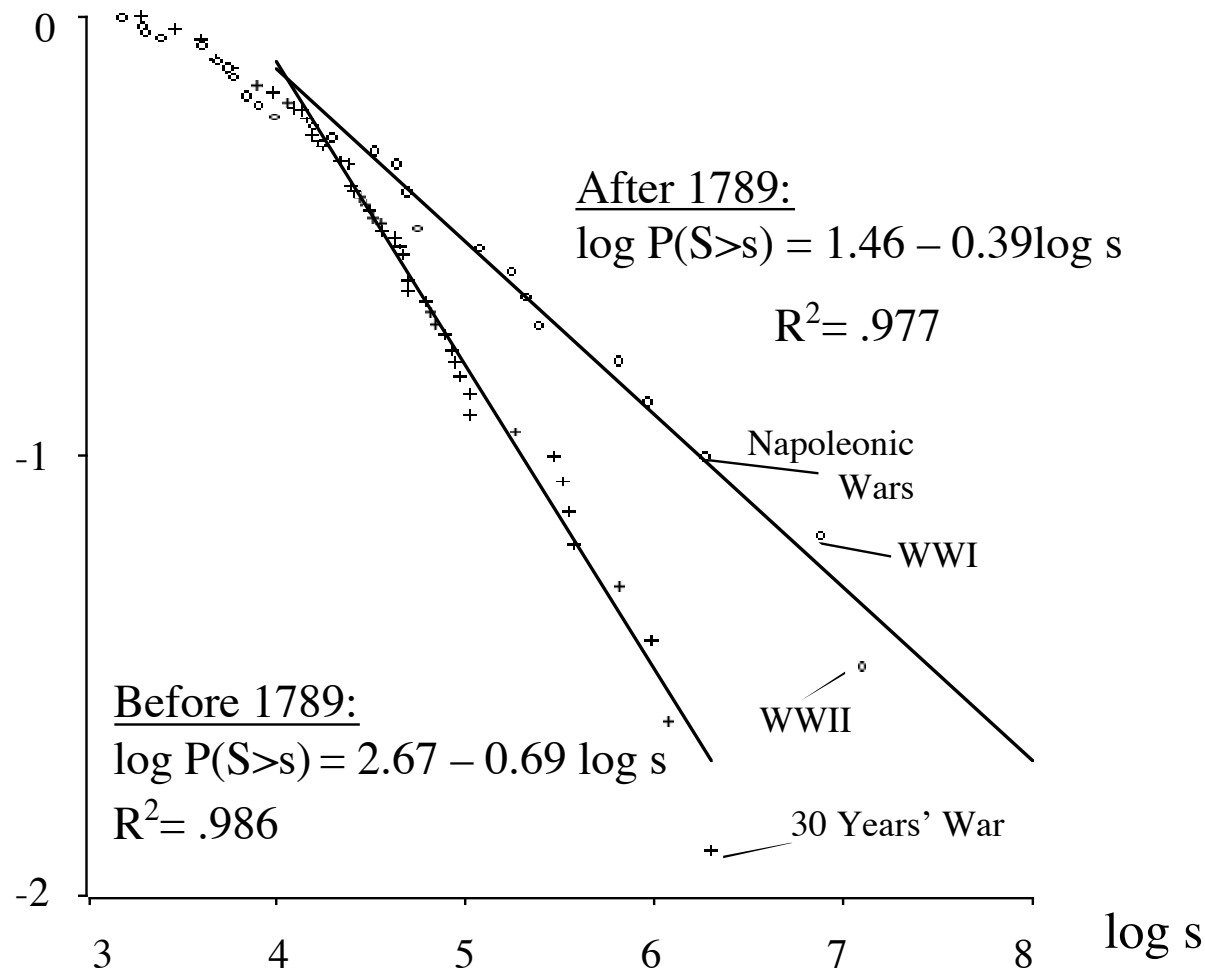


Data: Levy 1983

Analysis with Pisarenko & Sornette

Warfare before and after the French Revolution

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 $\log P(S>s)$ 

*Data:
Levy 1983*

Nationalism-based explanati0ns

H_1 : Nationalism \Rightarrow Power imbalance \Rightarrow
War

Mechanisms:

H_2 : Nationalist behavior more risk-willing

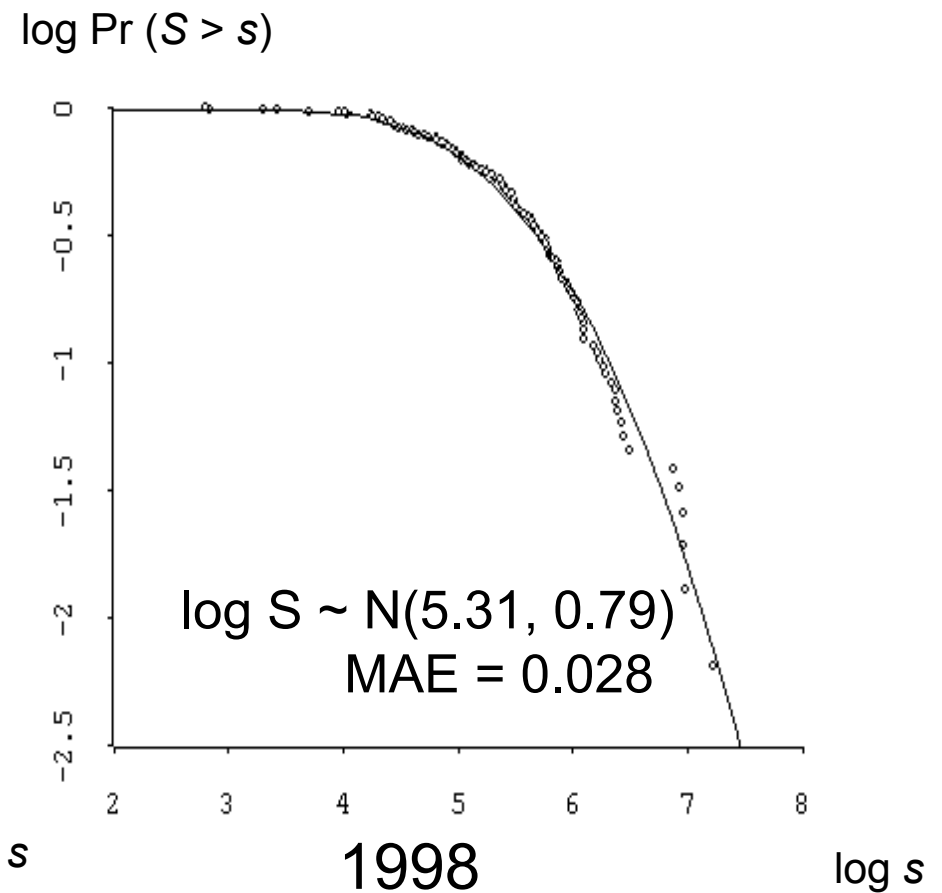
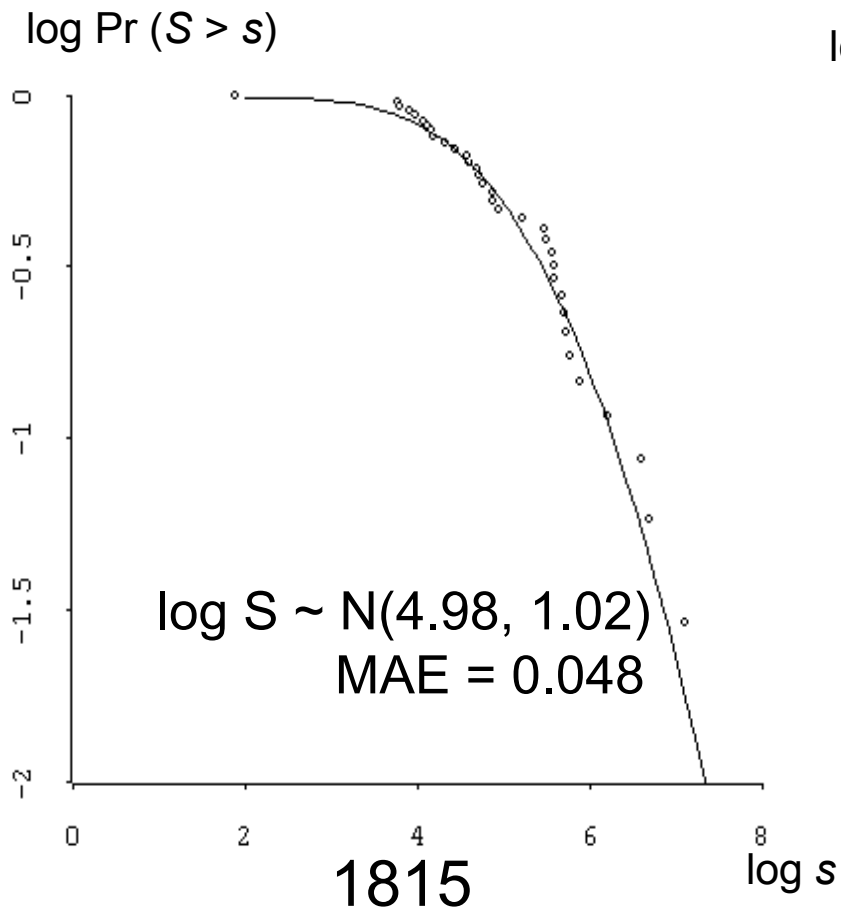
H_3 : Nationalist resource extraction more effective

H_4 : Nationalist mobilization at uneven speeds

H_5 : Nationalist secession and unification

Territorial state sizes

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Data: Lake et al.

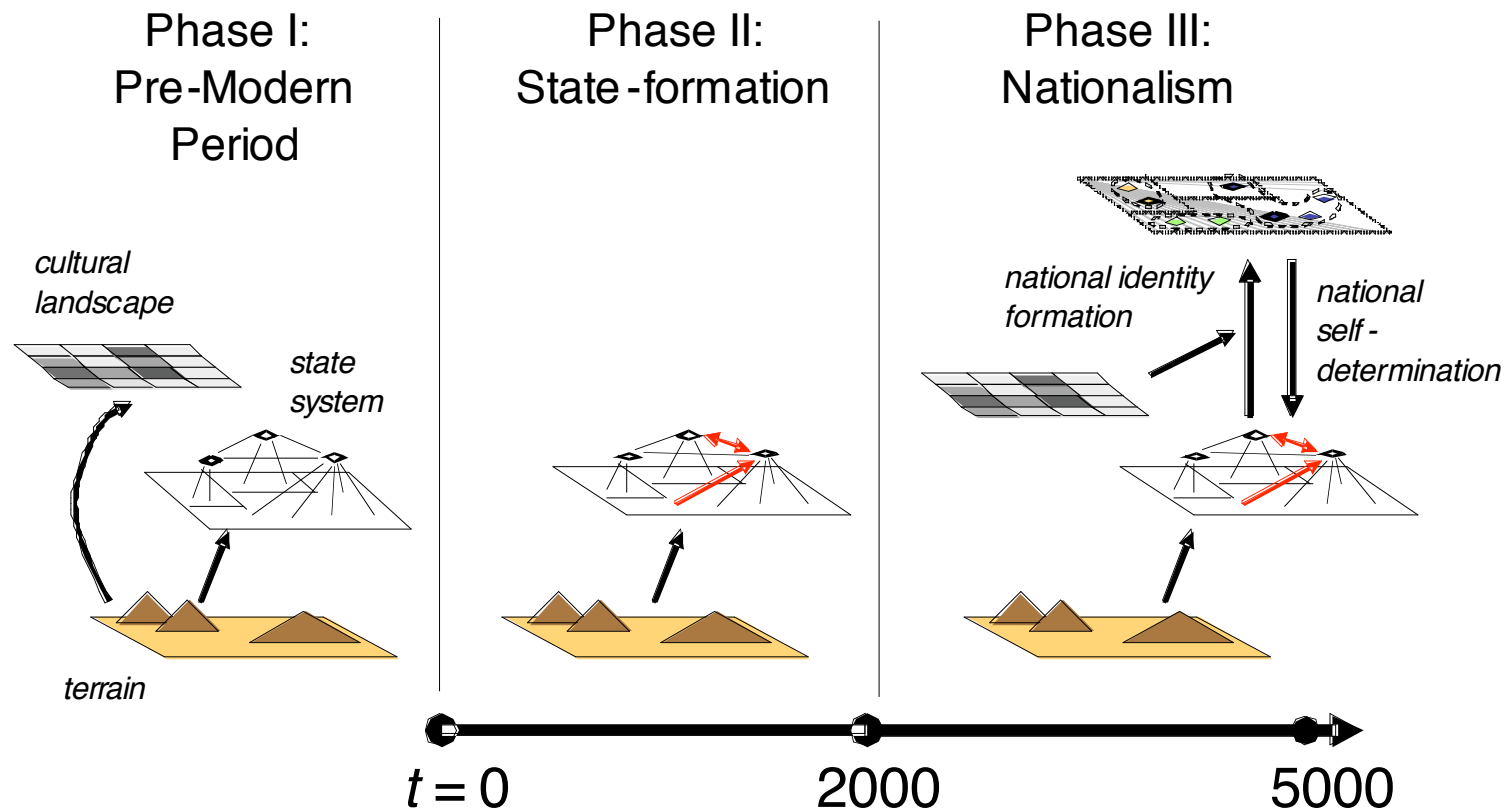
Estimated means, 1815-1998

27

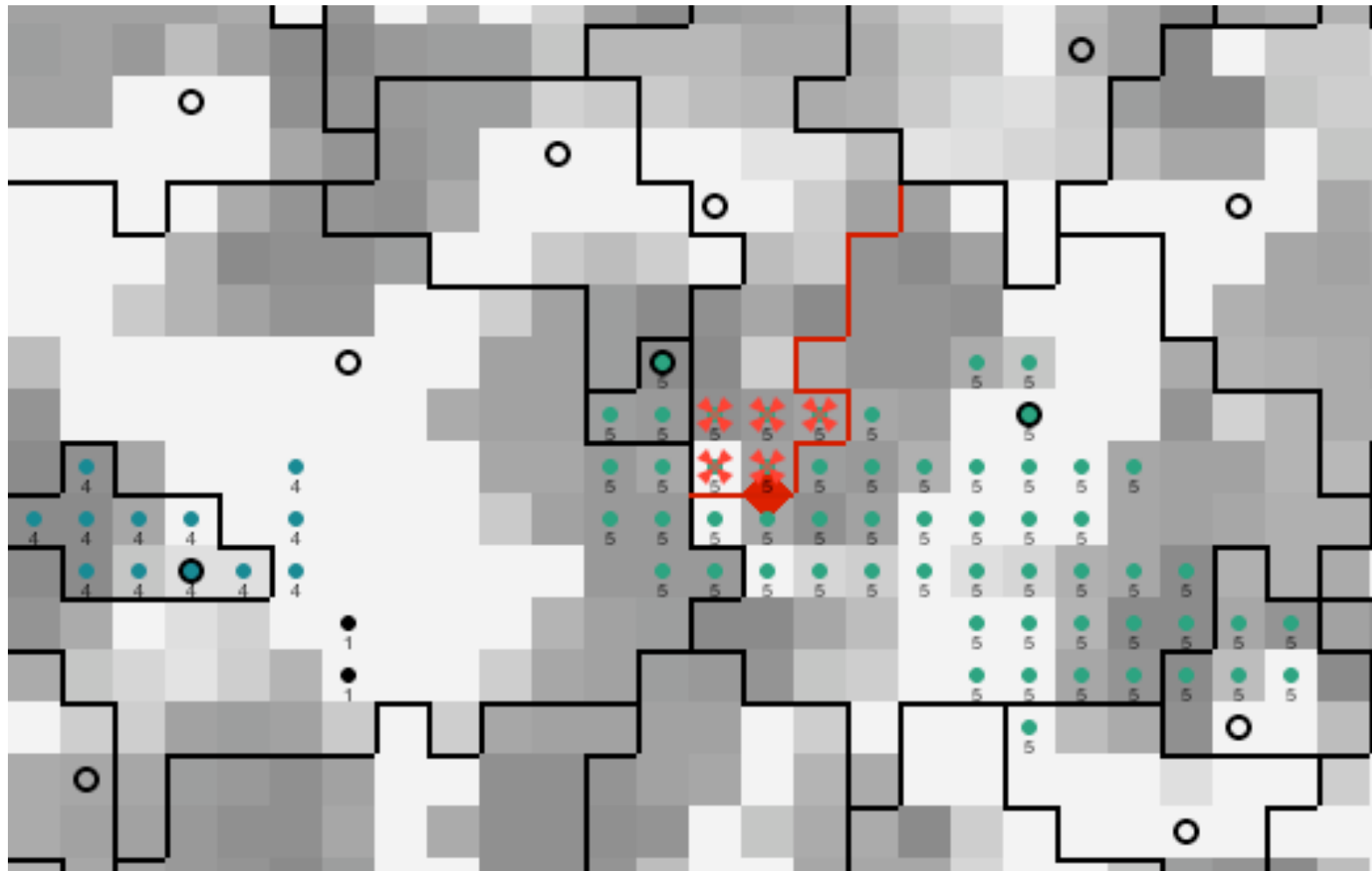
 μ 

Year

Nested processes

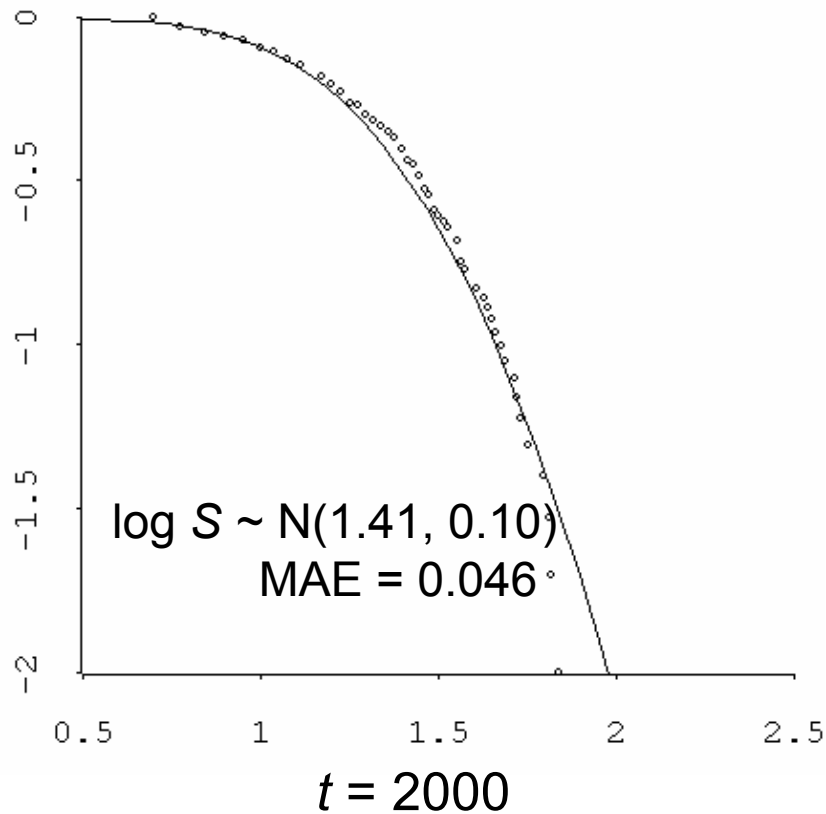
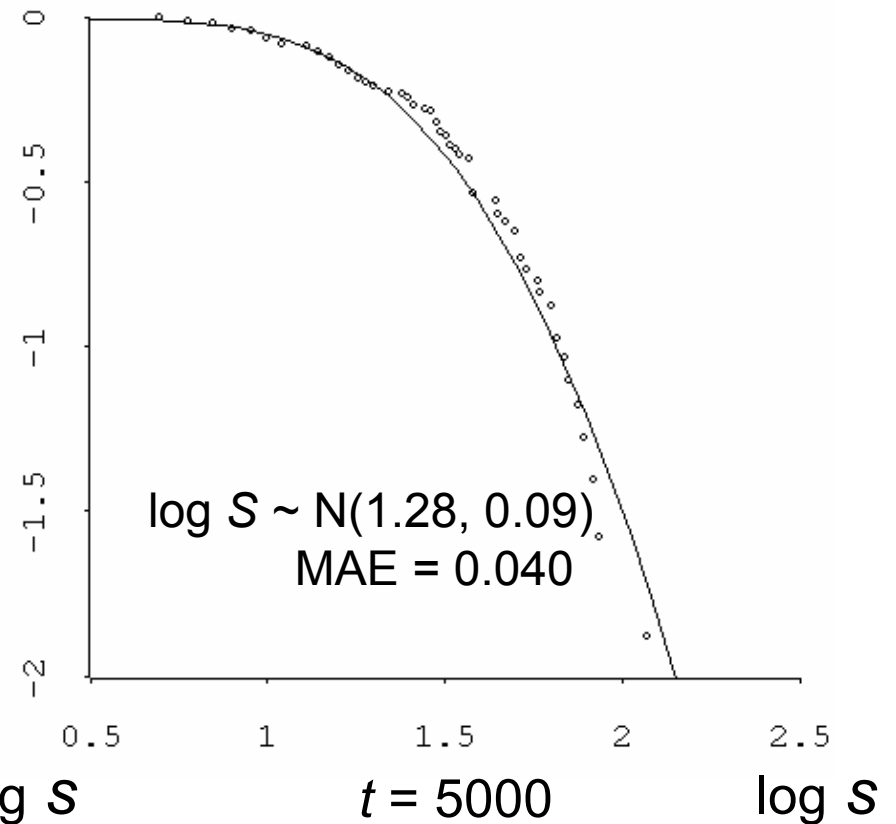


Geosim 5 Model



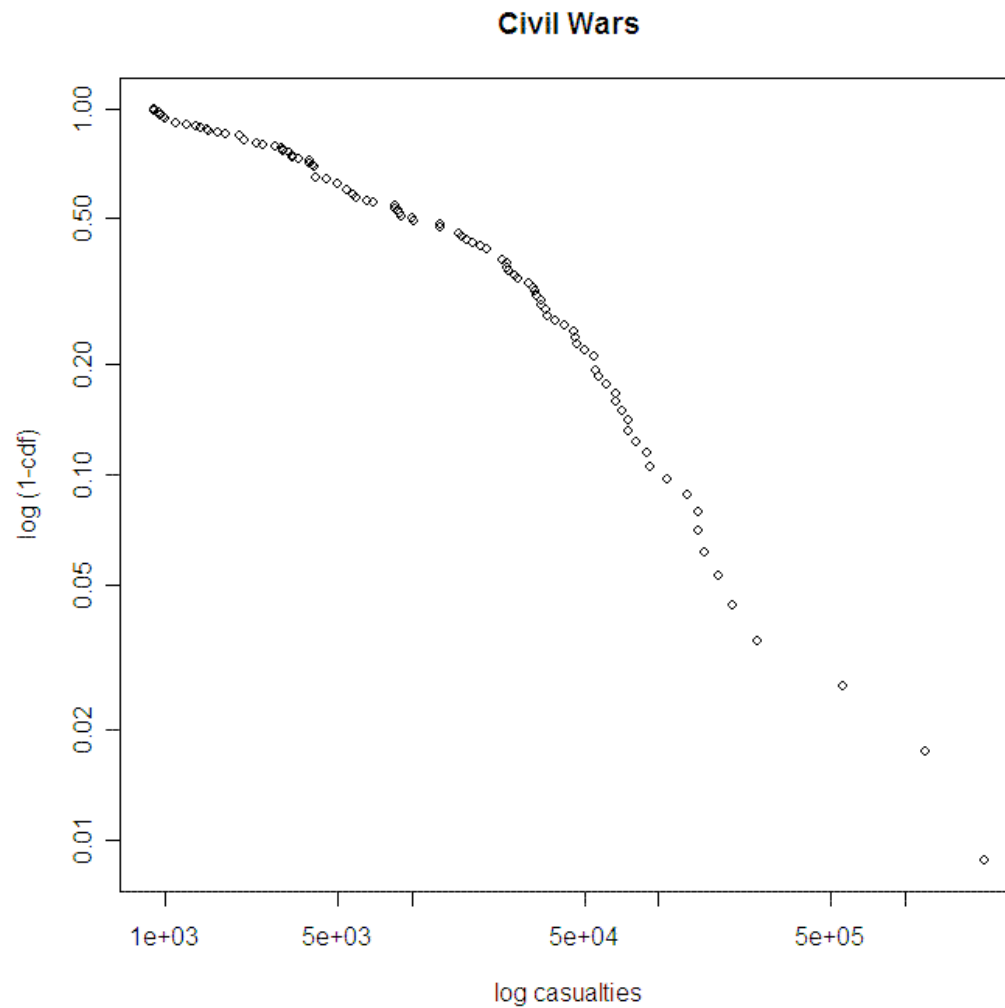
Simulated state sizes fitted by log-normal curve

30

 $\log \Pr(S > s)$  $\log \Pr(S > s)$ 

Civil war casualties

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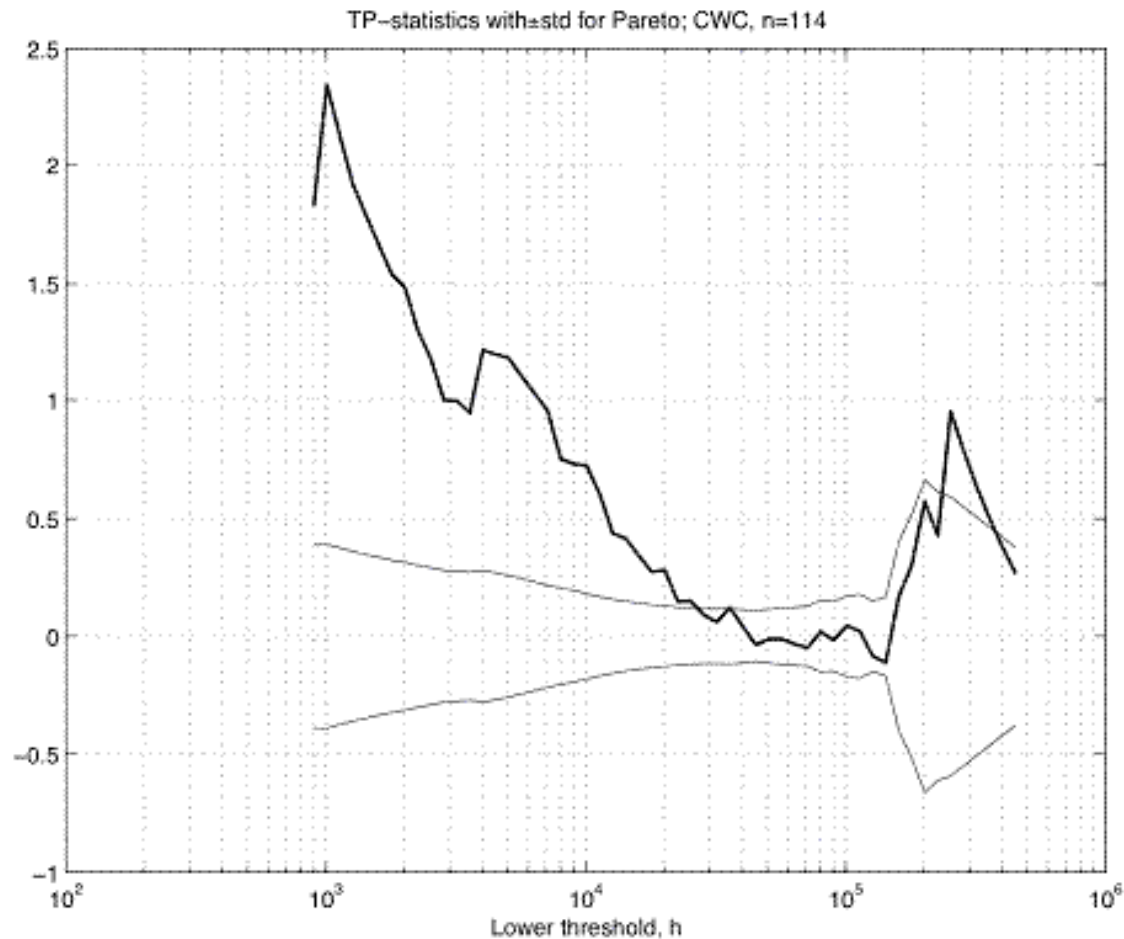


Source:
Lacina 2006

Civil war casualties:

Test of upper tail as a function of lower threshold

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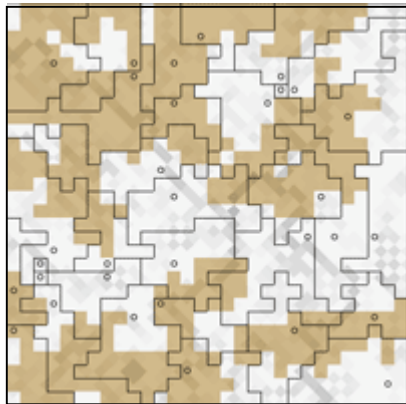
*Analysis with
Pisarenko &
Sornette*

Exploring geopolitics using agent-based modeling

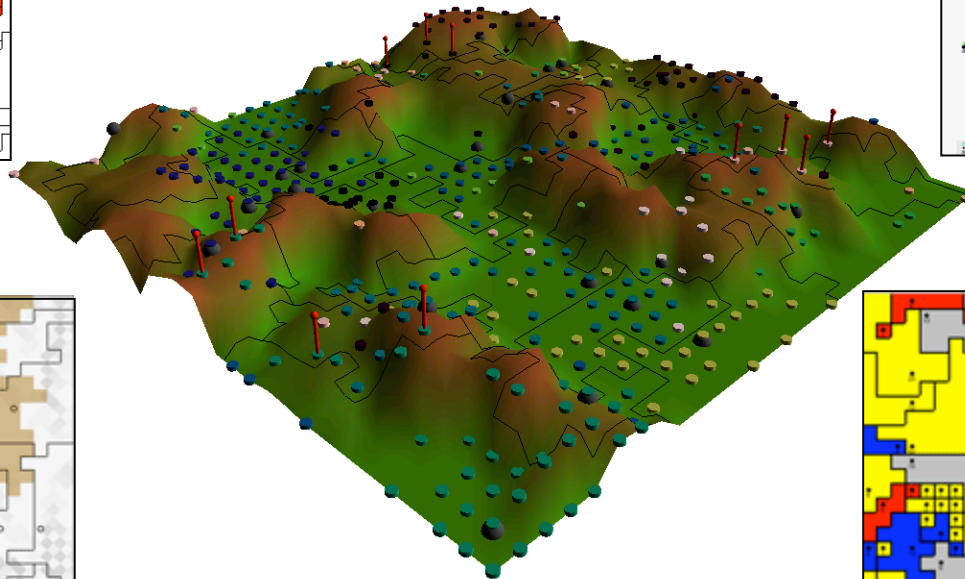
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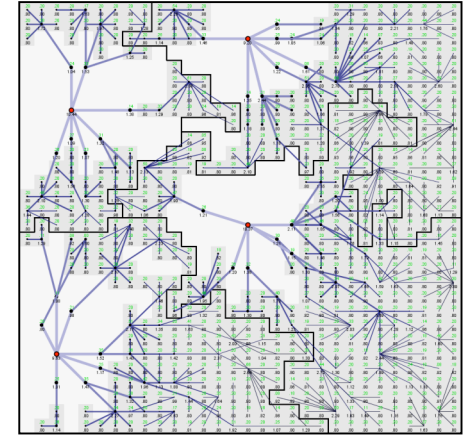
GeoSim 0



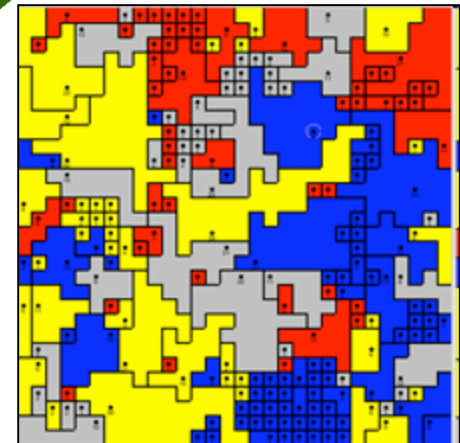
GeoSim 4



GeoSim 5



OrgForms



GeoContest

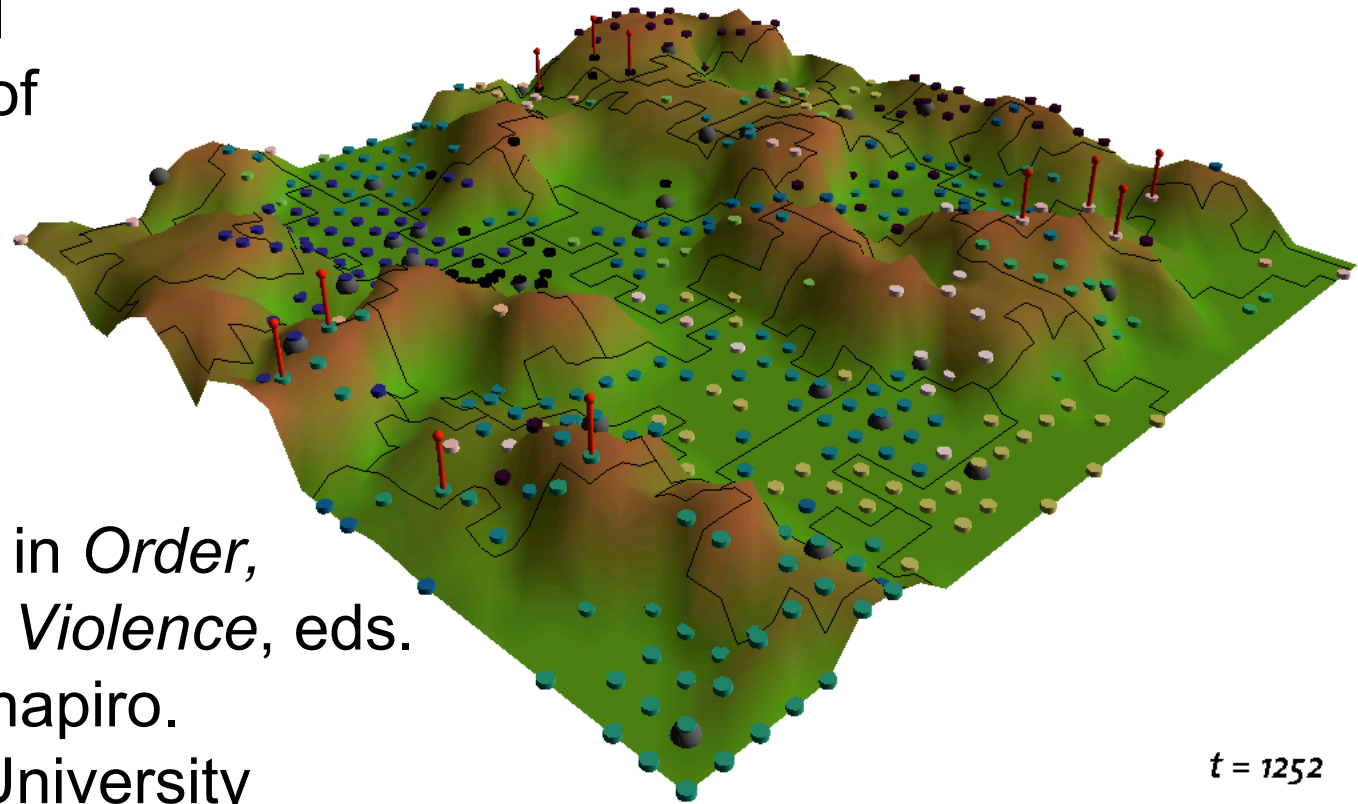
Toward more realistic models of civil wars

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

Step I: Nationalist insurgency model

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



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

 $t = 1252$

Step II: GREG Geo-Referencing of Ethnic Groups

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



Step II: ESEG Expert Survey of Ethnic Groups

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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

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Expert Survey on Ethnic Groups (ESEG)

Sweden

This is the main page for data entry on group lists.

Time Periods

First, please determine if the list of groups or their access to power changed significantly during the sample period 1945-1999. If this was the case, you should create additional time periods for which you can provide separate input. You are asked to input start and end dates for each time period. Please make sure that the entire sample period is covered without any gaps or overlaps.

Please choose a period: 1946-1999

Current period range from 1946 to 1999

Group List

Once you have created time periods, if any, please enter the politically relevant groups. You can create an entirely new group list by repeatedly using the button "Create New Group" or you can base your own selection on pre-existing lists by using the button "Import Groups from". Any selection can be further modified by creating or deleting groups. Group deletion is carried out by first checking the groups to be deleted and then pressing the button "Delete Checked".

Name	Size	Status
<input type="checkbox"/> Swedes	7200000.0	Please choose...
<input type="checkbox"/> Finns	1100000.0	Please choose...
<input type="checkbox"/> Germans	500000.0	Please choose...
<input type="checkbox"/> Others and Unknown	450000.0	Please choose...
<input type="checkbox"/> Norwegians	400000.0	Please choose...
<input type="checkbox"/> Danes	350000.0	Please choose...
<input type="checkbox"/> Estonians	200000.0	Please choose...
<input type="checkbox"/> European and American Jews	100000.0	Please choose...
<input type="checkbox"/> Seami	100000.0	Please choose...
<input type="button" value="Create New Group"/> <input type="button" value="Delete Checked"/> <input type="button" value="Import Groups from"/> <input type="button" value="Soviet Atlas Narodov Mira"/>		
<input type="button" value="Save Changes"/>		

For each group, please provide a name, the share of the population, and their access to power

Step III: GROWLab

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