ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich
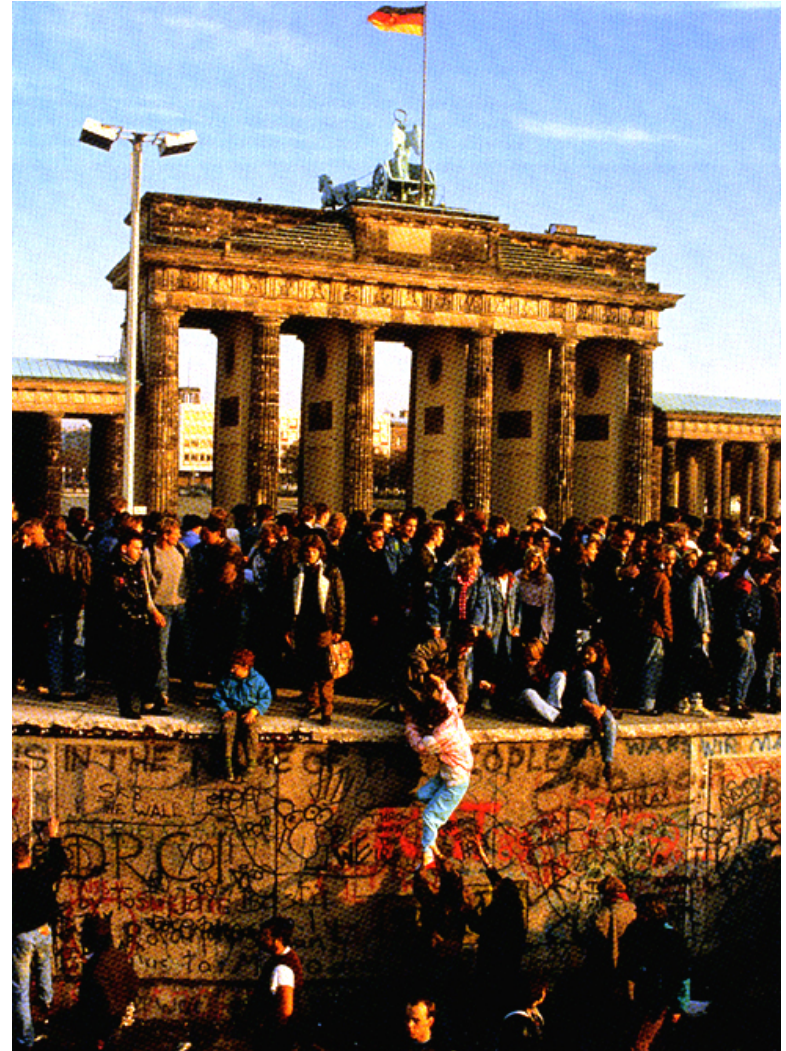
INTERNATIONAL CONFLICT RESEARCH

Agent-Based Models of Geopolitical Processes

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A time of flux

Challenges of complexity

Time

Challenges of complexity
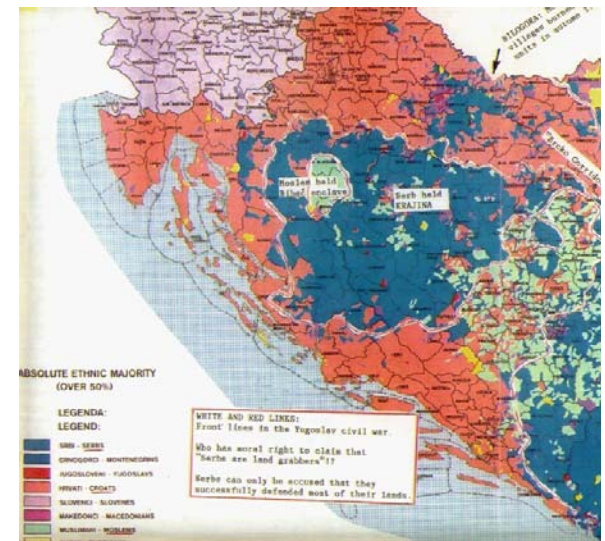
Time
Space

Challenges of complexity

## Time   Space   Identity

Sociological process theory

- Georg Simmel
- *Vergesellschaftung*
- Large social organizations exist despite:
  - long duration
  - vast spatial extension
  - diversity of their members

Complexity theory

Complex adaptive systems exhibit properties that emerge from local interactions among many heterogeneous agents mutually constituting their own environment
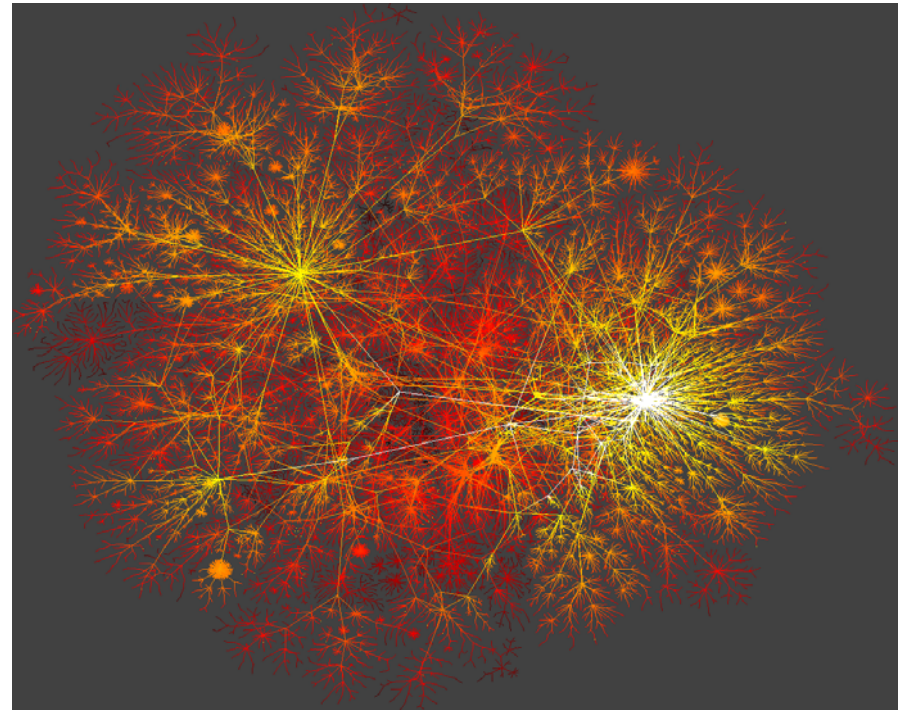
A model of the Internet

"Boids"

The Santa Fe Institute

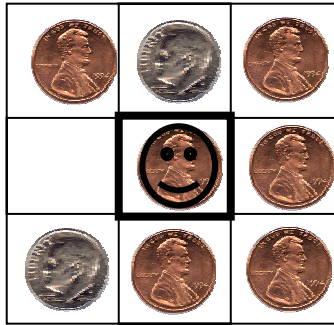# A view from the Berlin television tower

Ethnic neighborhoods

Chinatown, New York City

Little Italy, New York City
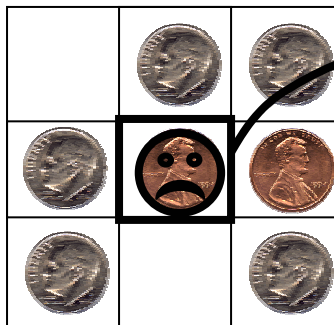
Neighborhood segregation
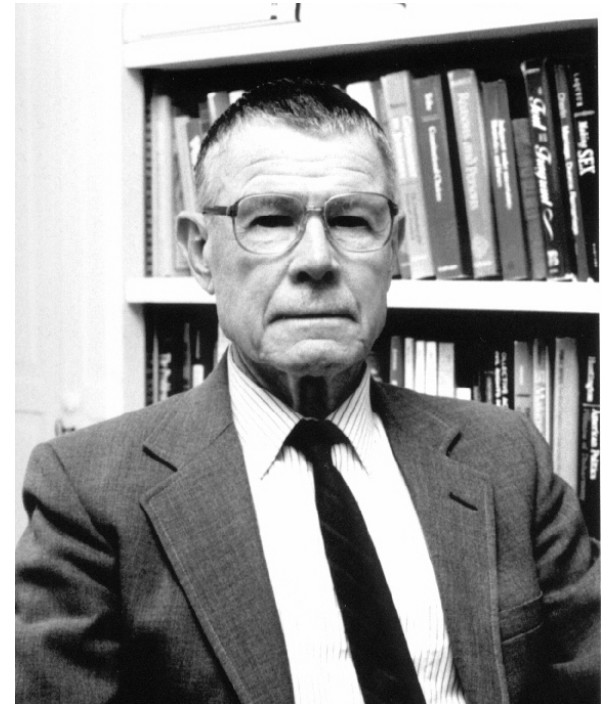
Micro-level rules of the game

Stay if at least a third of neighbors are "kin"
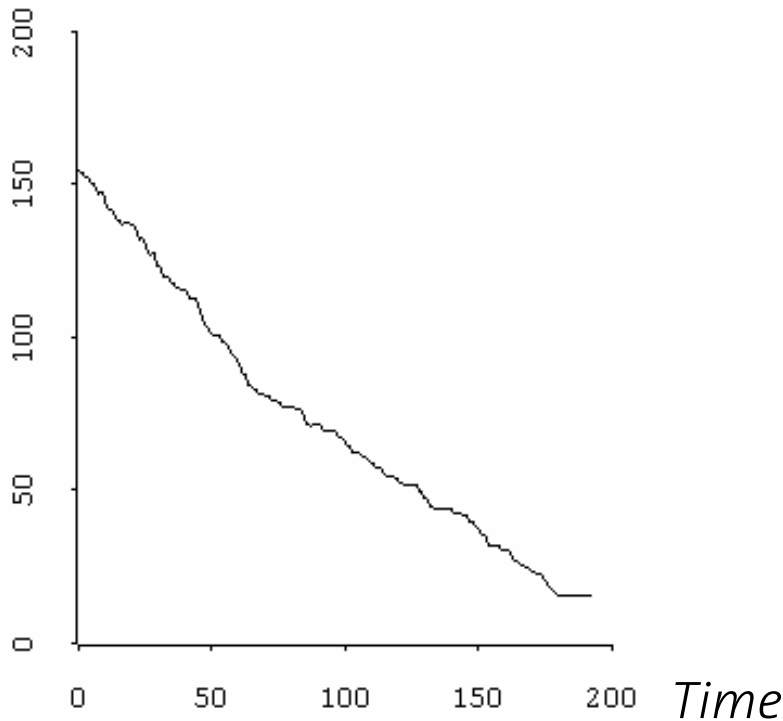
< 1/3

Move to random location otherwise

Thomas C. Schelling

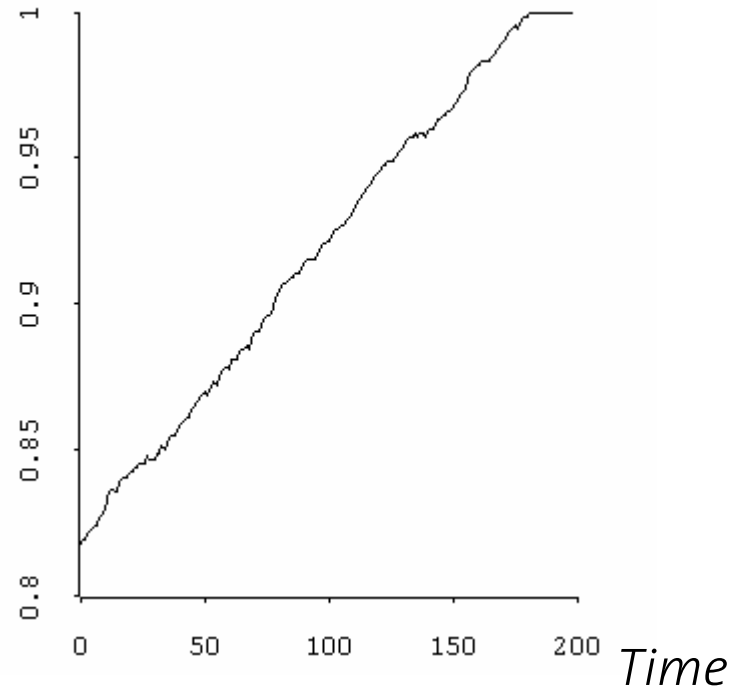*Micromotives and Macrobehavior*

Sample run 1

- [Schelling's Segregation Model](#)

Emergent results from Schelling's segregation model

Number of neighborhoods

Happiness

Time

Time
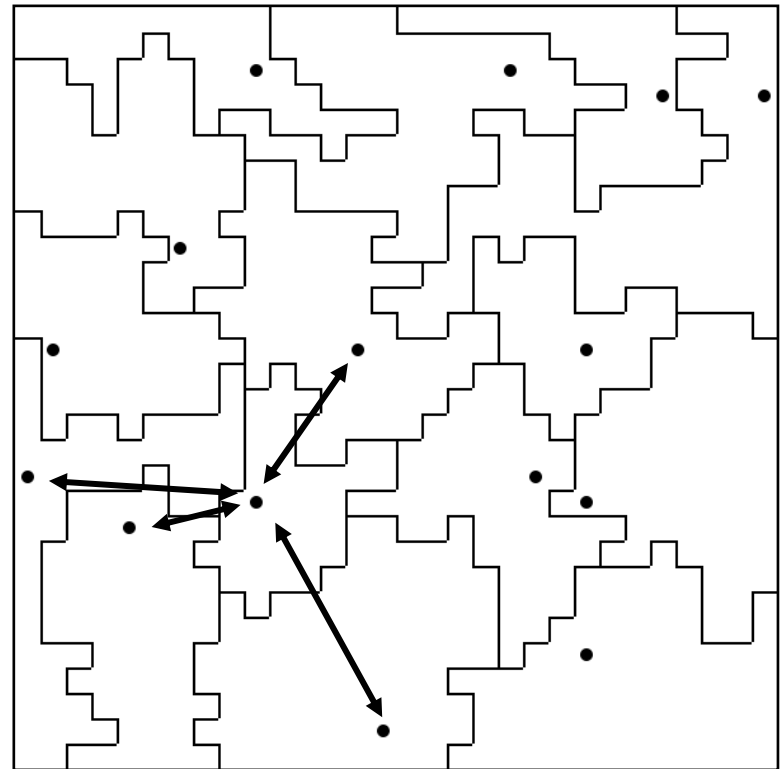
Europe in 1500

Europe in 1900

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

Geosim

- Geosim uses Repast, a Java toolkit

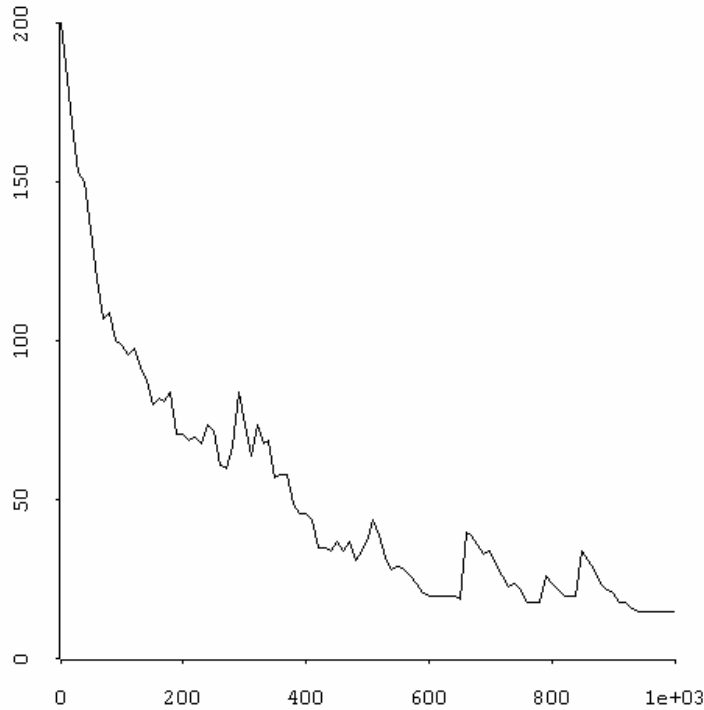- States are hierarchical, bounded actors interacting in a dynamic network imposed on a grid
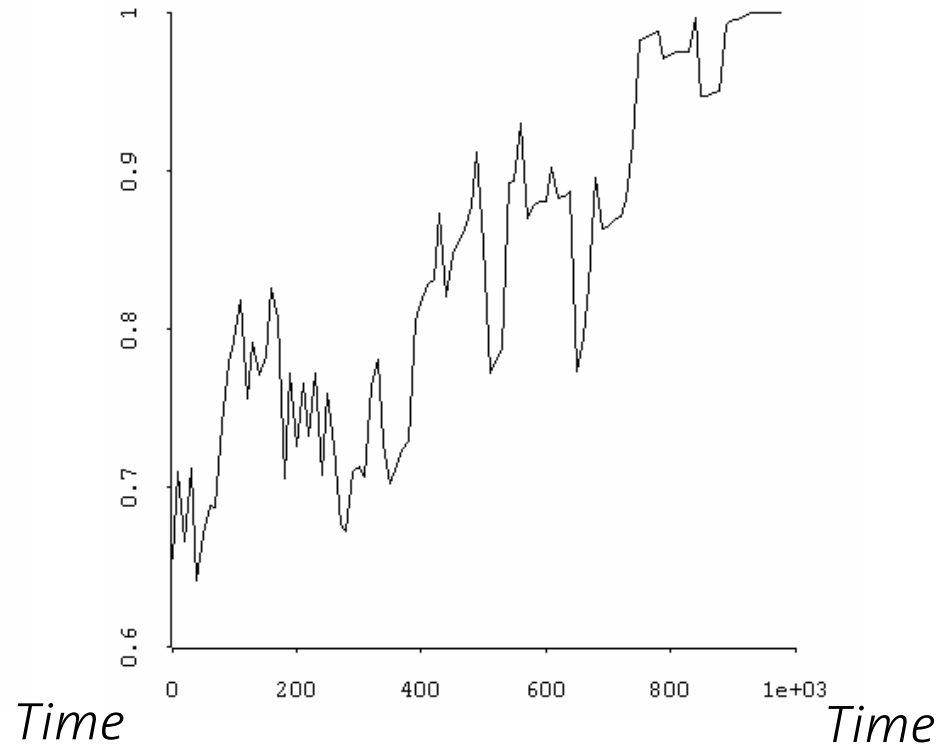
Sample Run 2

- [Geosim Base Model](#)
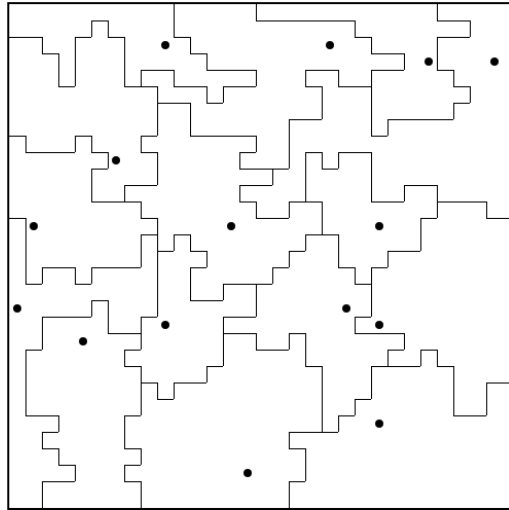
Emergent results from the run

*Number of
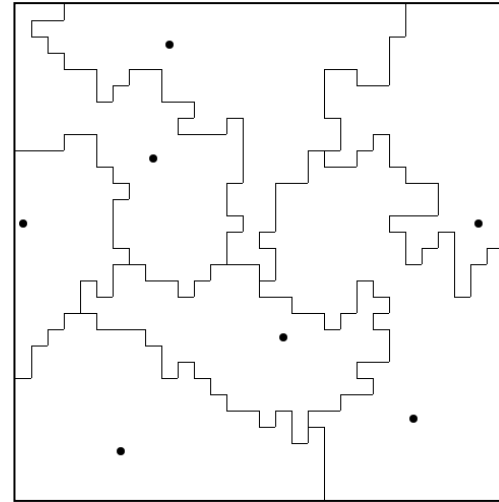states*

*Proportion of
secure areas*

Time

Time

Possible outcomes
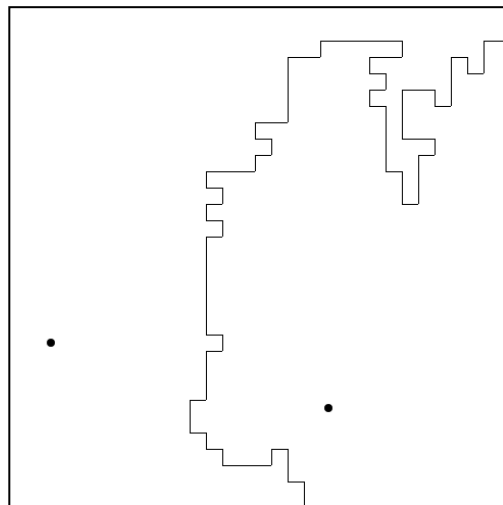

15-state multipolarity (sample run)

7-state multipolarity

bipolarity

unipolarity
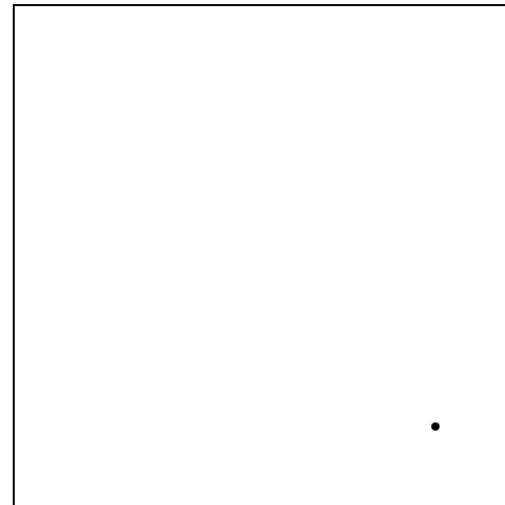
Applying Geosim to world politics

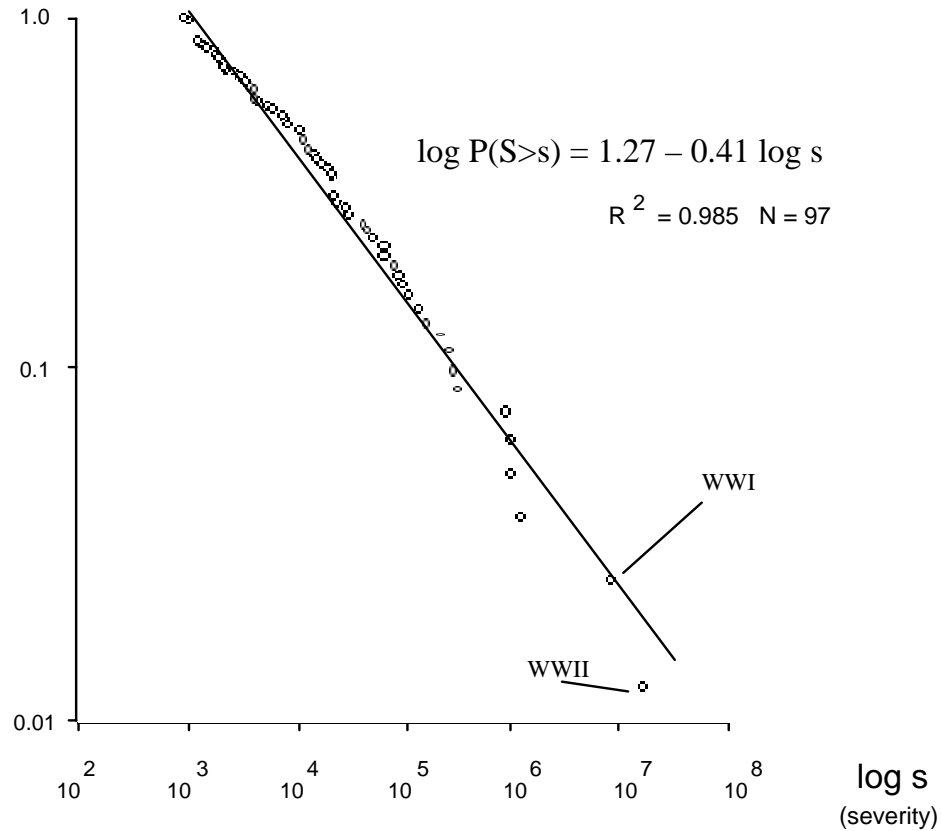|	Process	Configuration
Distributional properties	**Example 1. War-size distributions**	Example 2. State-size distributions
Qualitative properties	Example 4. Nationalist insurgencies	Example 3. Democratic peace

Cumulative war-size plot, 1820-1997

log P(S>s)
(cumulative frequency)

$$\log P(S>s) = 1.27 - 0.41 \log s$$

$R^2 = 0.985 \quad N = 97$

WWI

WWII

Data Source:
Correlates
of War
Project (COW)

log s
(severity)

Self-organized criticality

Per Bak's sand pile
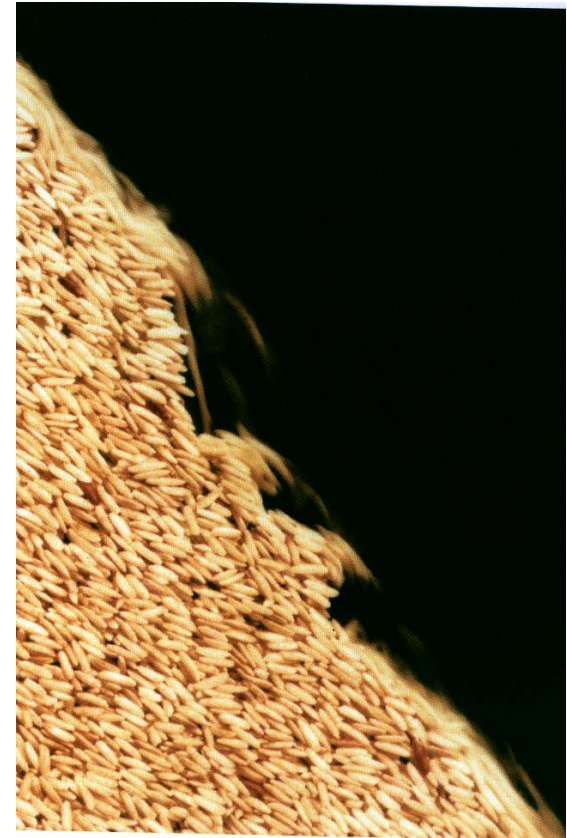
Power-law distributed avalanches in a rice pile

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Simulated cumulative war-size plot

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

log P($S > s$) = 1.68 − 0.64 log s
N = 218 R^2 = 0.991

log s
(severity)
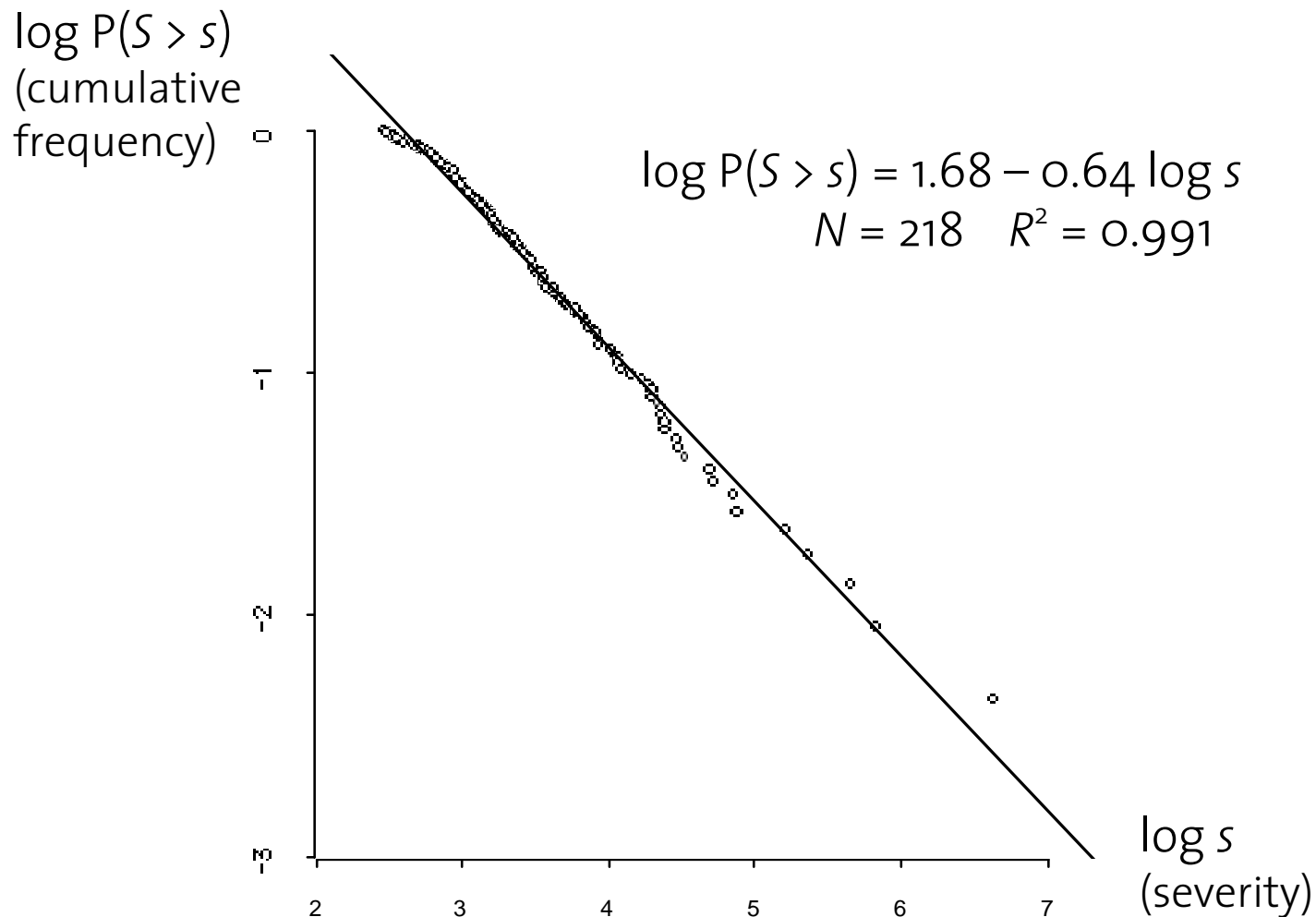
See "Modeling the Size of Wars" *American Political Science Review* Feb. 2003

Applying Geosim to world politics

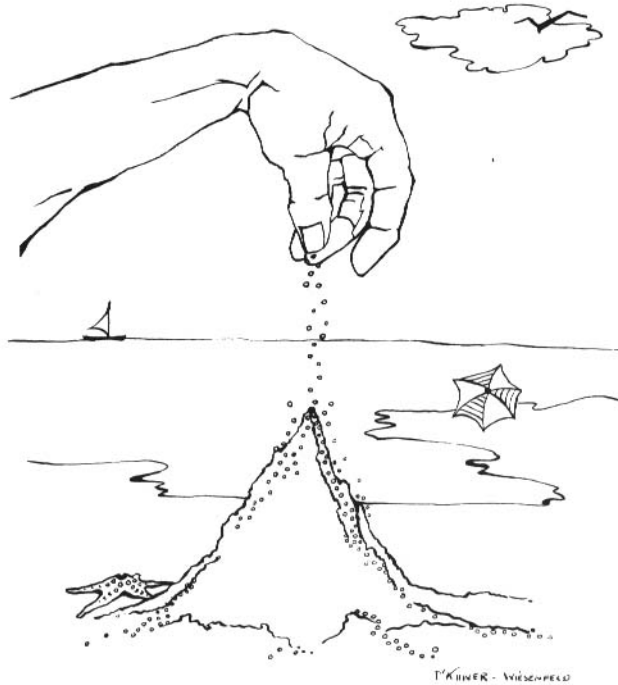|	Process	Configuration
Distributional properties	Example 1. War-size distributions	**Example 2. State-size distributions**
Qualitative properties	Example 4. Nationalist insurgencies	Example 3. Democratic peace

2. Modeling state sizes: Empirical data
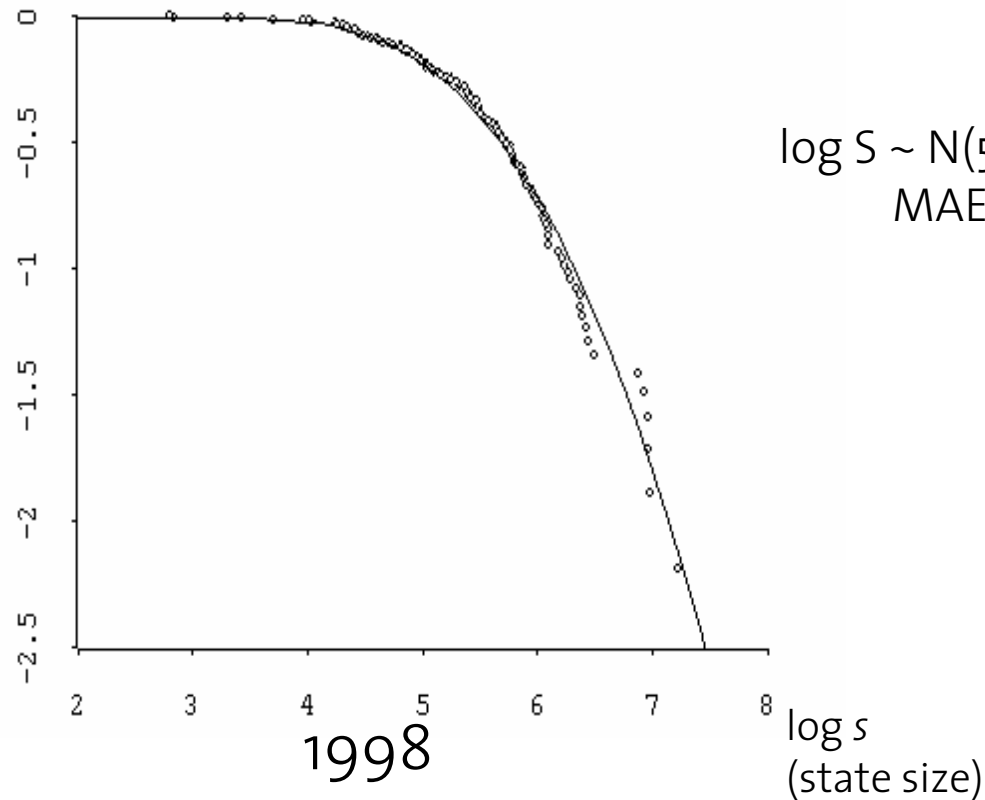
log Pr $(S > s)$
(cumulative frequency)

log S ~ N(5.31, 0.79)
MAE = 0.028

1998

log s
(state size)

Data: Lake et al.

Simulating state size with terrain

Simulated state-size distribution

log Pr (*S* > *s*)
(cumulative frequency)

log S ~ N(1.47, 0.53)
MAE = 0.050

log *s*
(state size)

Applying Geosim to world politics

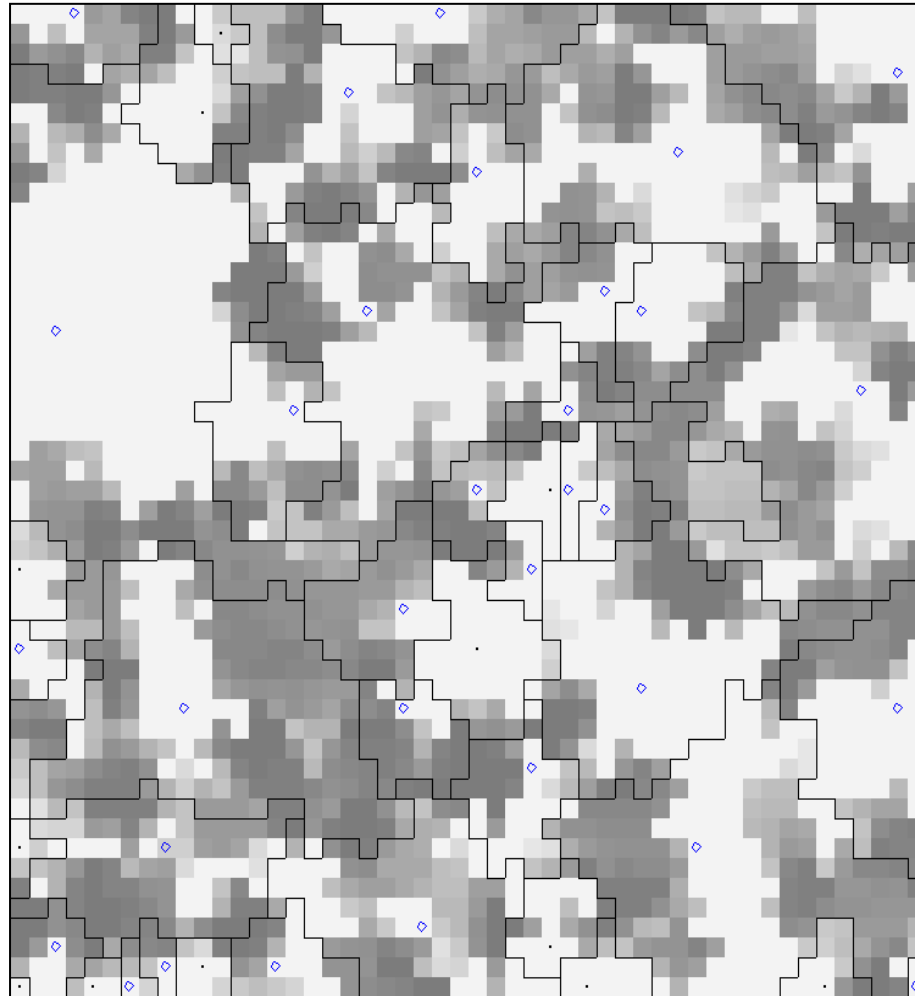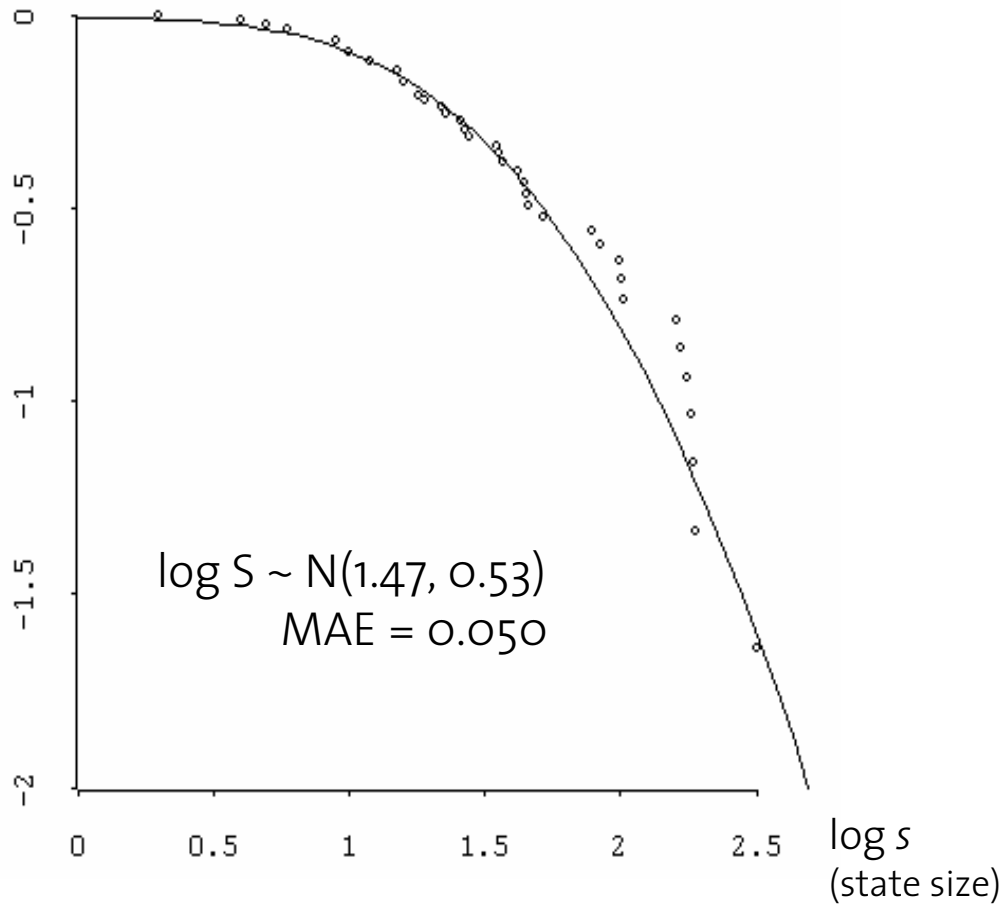|	Process	Configuration
Distributional properties	Example 1. War-size distributions	Example 2. State-size distributions
Qualitative properties	Example 4. Nationalist insurgencies	**Example 3. Democratic peace**

Simulating global democratization

Source:
Cederman &
Gleditsch 2004

A simulated democratic outcome

$t = 0$

$t = 10,000$

Applying Geosim to world politics

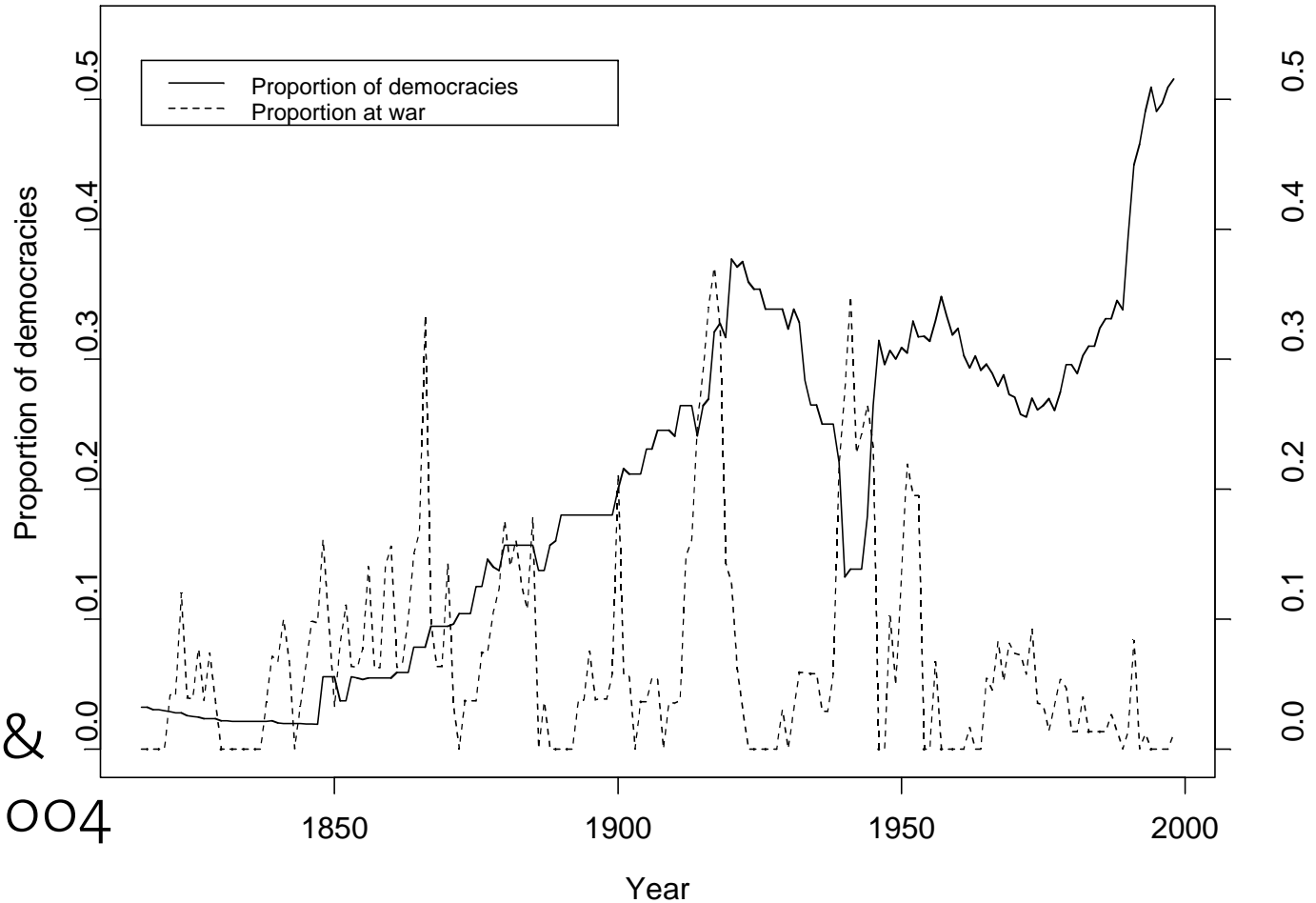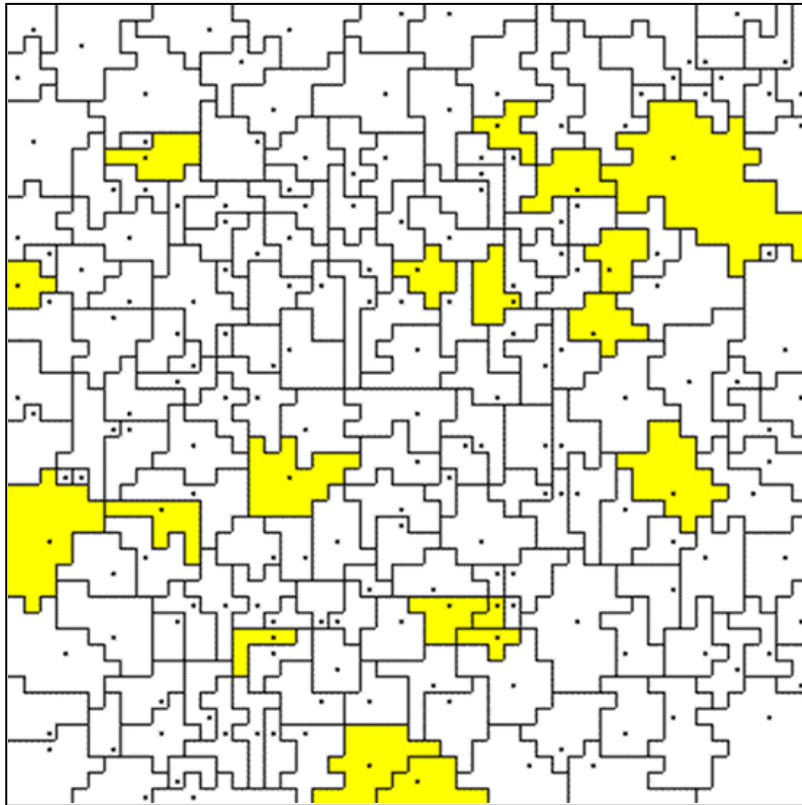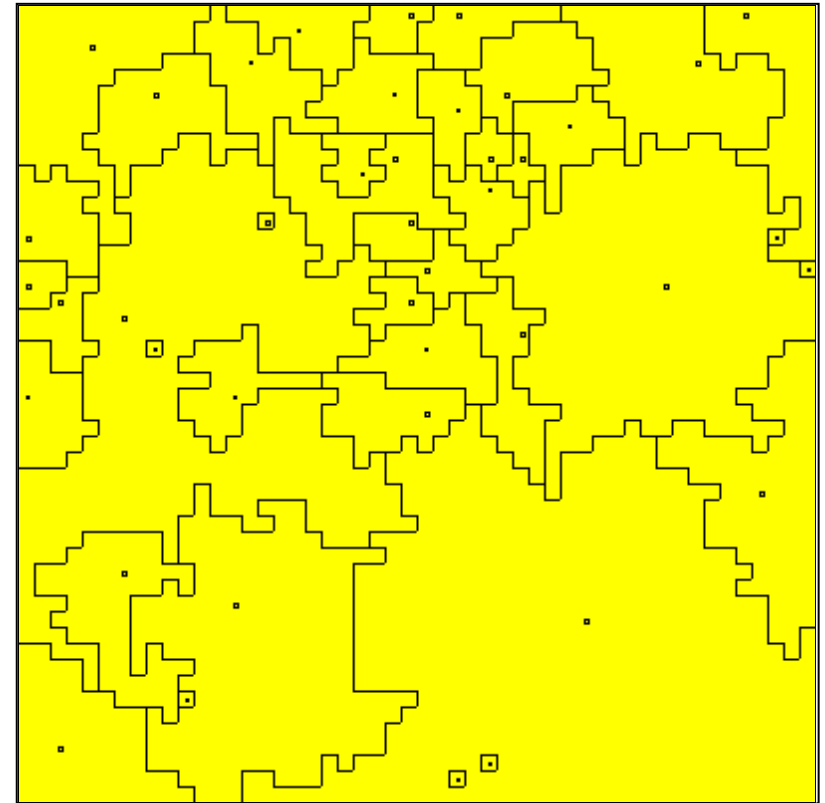|	Process	Configuration
Distributional properties	Example 1. War-size distributions	Example 2. State-size distributions
Qualitative properties	**Example 4. Nationalist insurgencies**	Example 3. Democratic peace

Sample run 3

- Geosim Insurgency Model

Future activities

- The International Conflict Research Group:

  http://www.icr.ethz.ch

- Search for Ph D students

- Annual courses on "Computational Models of Social Systems"

- TAICON = Trans-Atlantic Initiative on Complex Organizations and Networks (Harvard, ETH)

  – Inaugural lecture given by Duncan Watts, Columbia Univ., January 12, 2005

Claudia Jenny   Luc Girardin

Duncan Watts