



Konfliktforschung I

Kriegsursachen im historischen Kontext

Computersimulation und Konfliktforschung
am Beispiel von GeoSim

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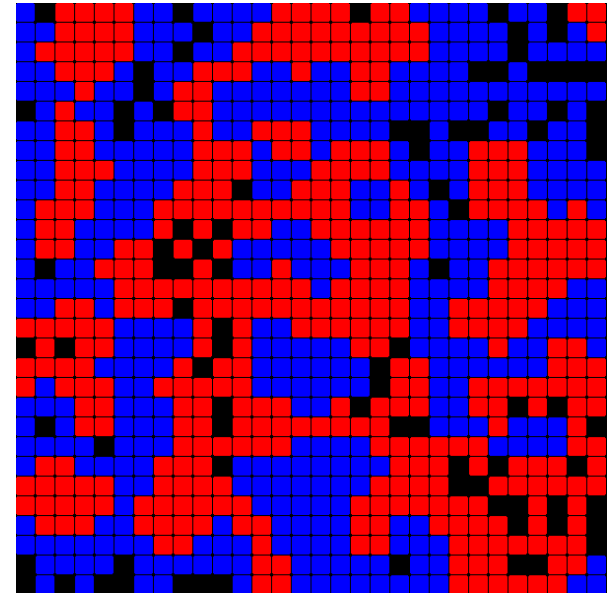
lcederman@ethz.ch

Agenda

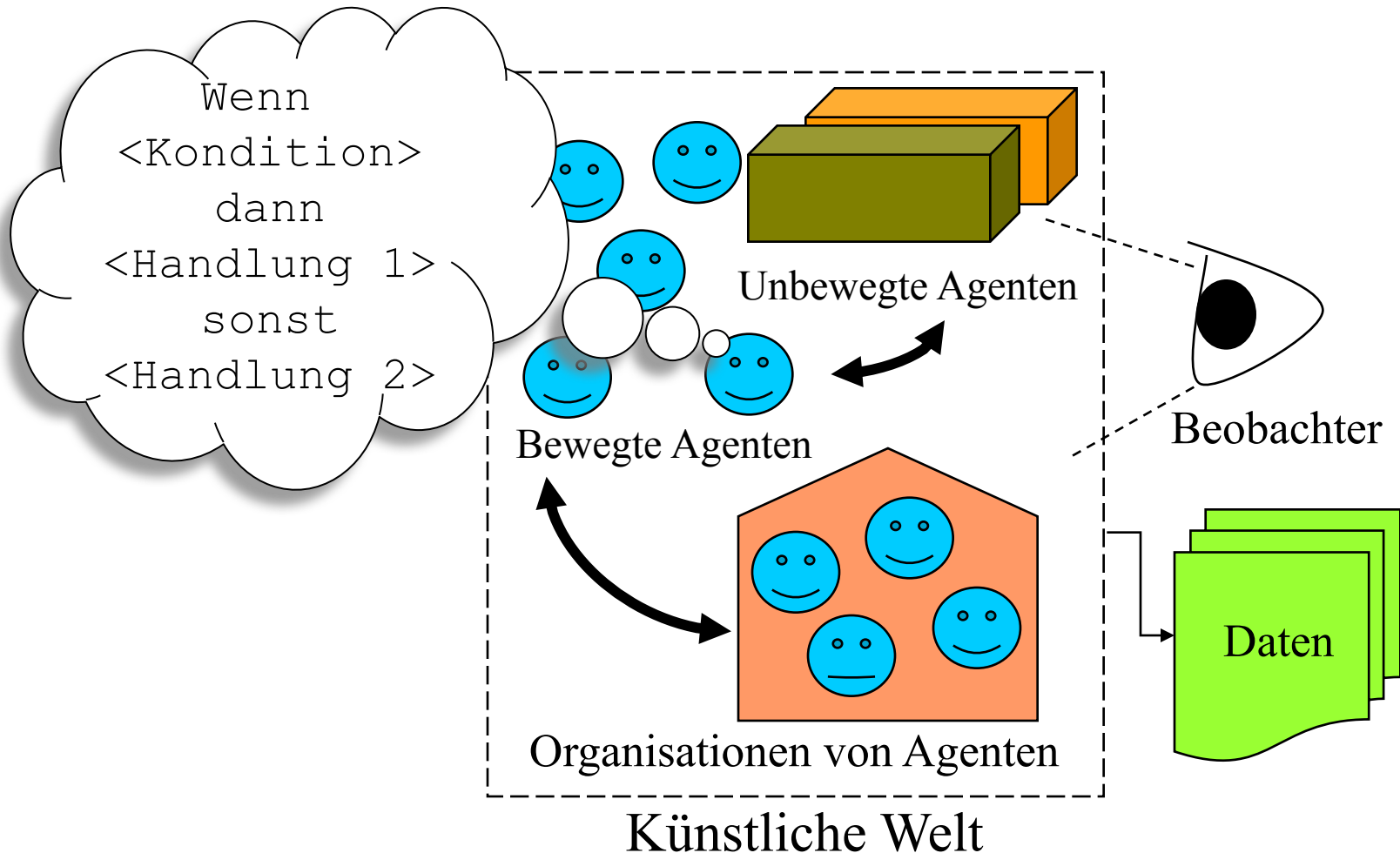
- Einführung in die agenten-basierte Modellierung
- Schellings Segregations-Model
- Einführung in Geosim
- Anwendungen in der Konfliktforschung

Definition

- ABM ist eine computergestützte Forschungsmethode, die es dem Forscher erlaubt, künstliche Welten zu kreieren, diese zu analysieren und damit zu experimentieren.
- Bottom-up
- Basiert auf zellularen Automata und verteilter künstlicher Intelligenz



Disaggregierte Modellierung



Blick vom Berliner Fernsehturm



Ethnische Stadtteile



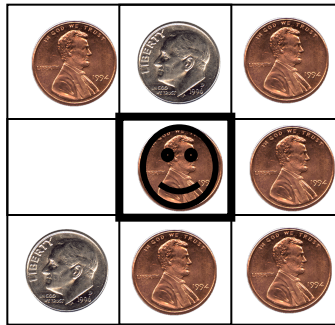
Chinatown, New York



Klein-Italien, San Diego

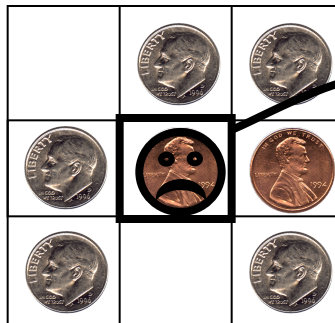
Nachbarschafts-Segregation

Die Spielregeln

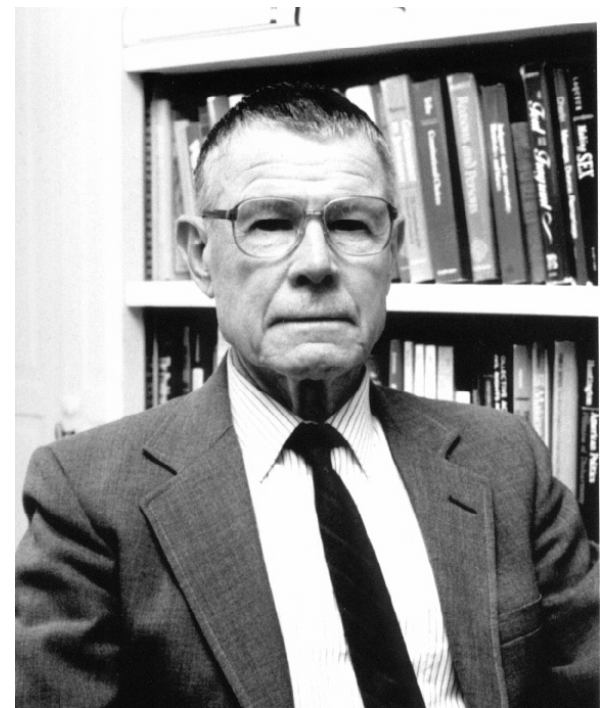


*Ein Agent bleibt,
wenn min. 1/3 der
Nachbarn „seiner
Art“ ist*

$< 1/3$

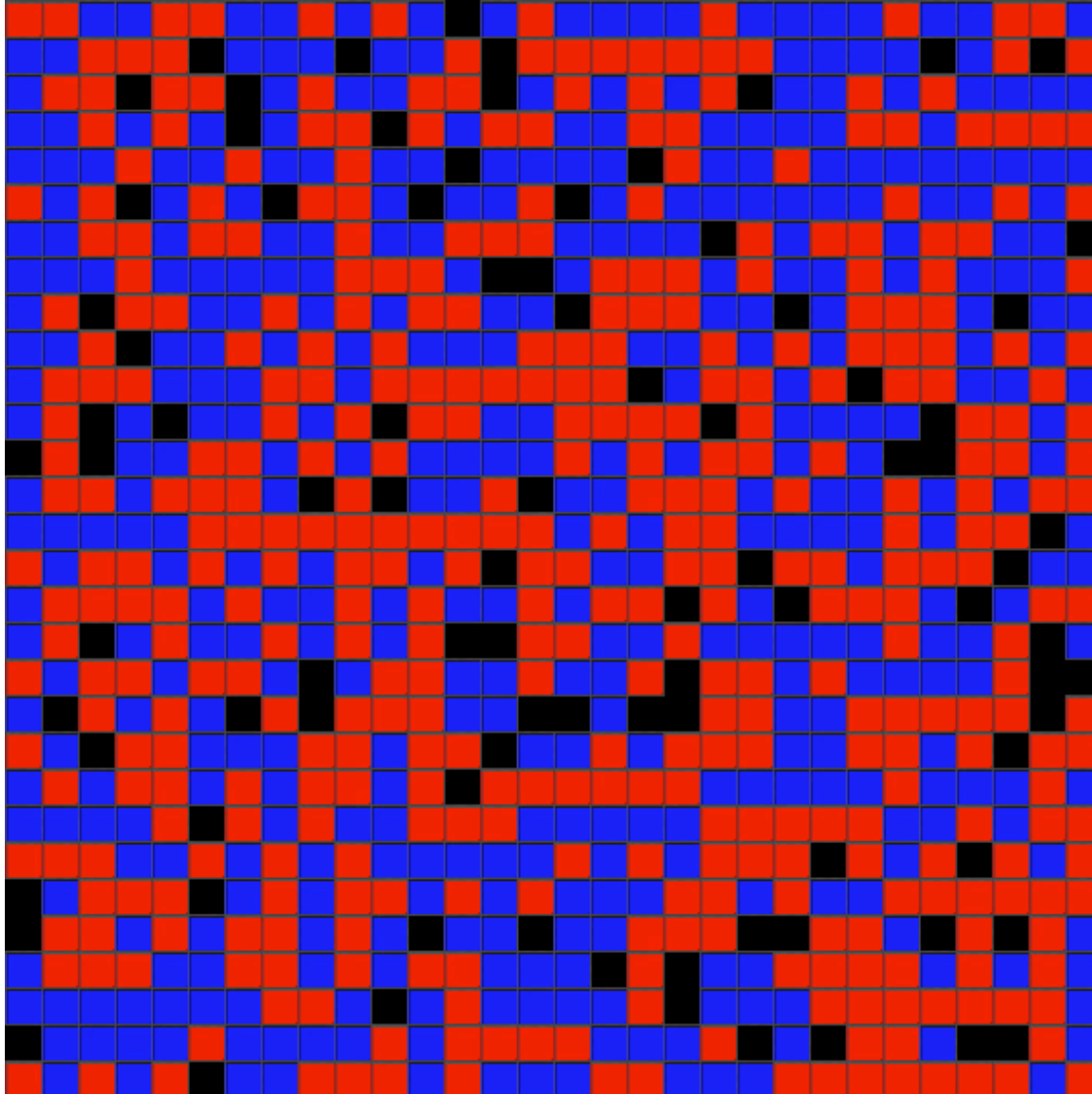


*Ansonsten zieht er auf
eine freie, angenehmere
Position um*



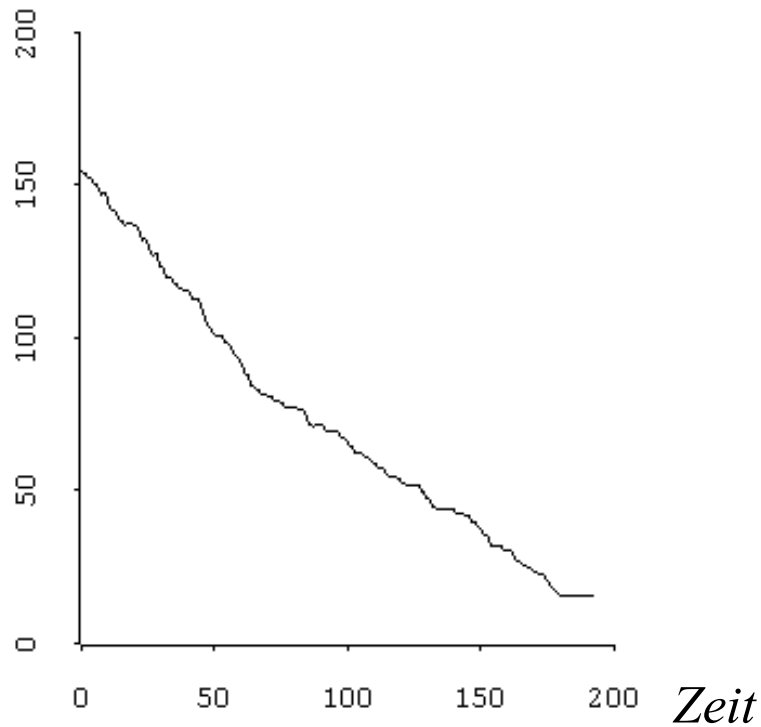
Thomas C. Schelling
Nobelpreis für Wirtschaft
2005

Vorführung 1

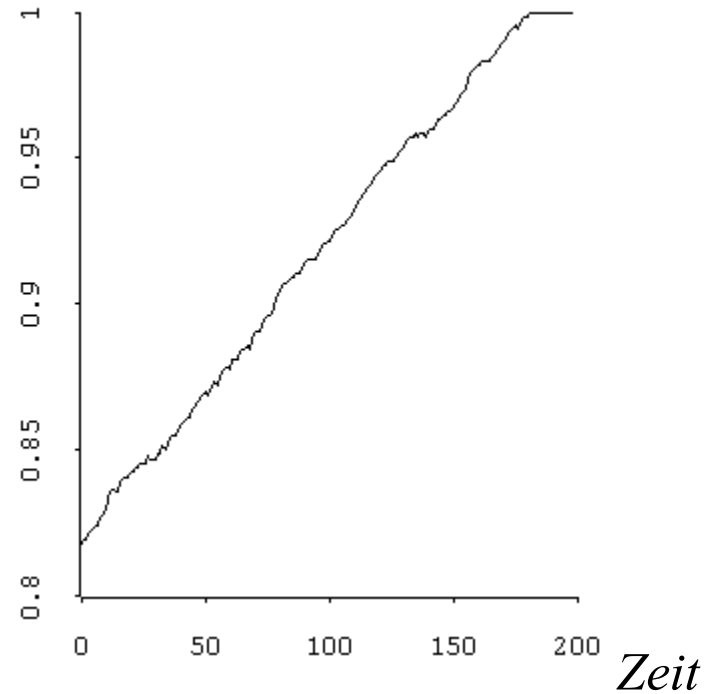


Ergebnisse des Modells

*Zahl der
Nachbarschaften*



Zufriedenheit



Europa um 1500



Europa um 1900

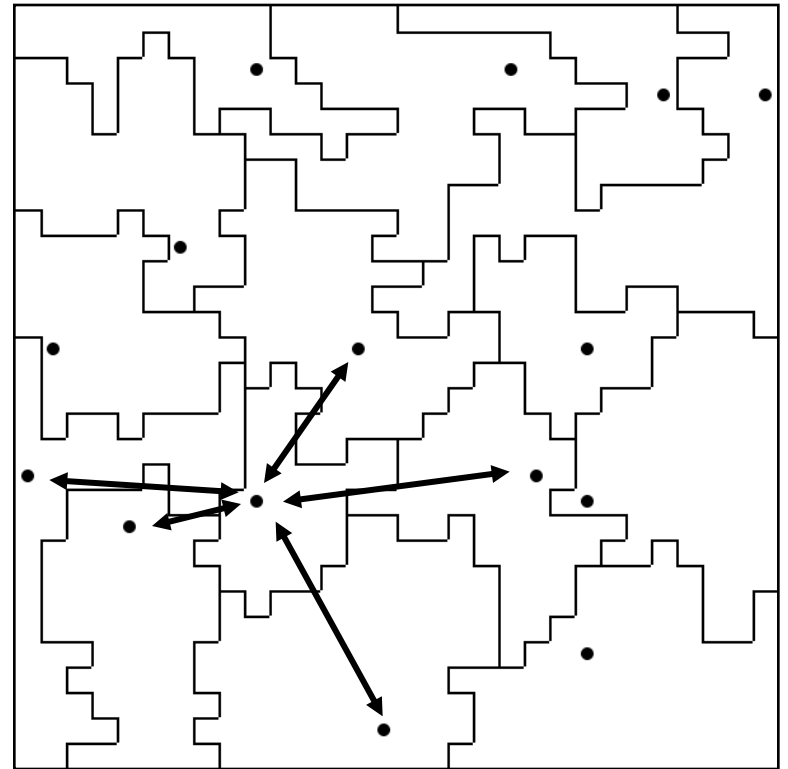


“States made war and war made the state” – *Charles Tilly*

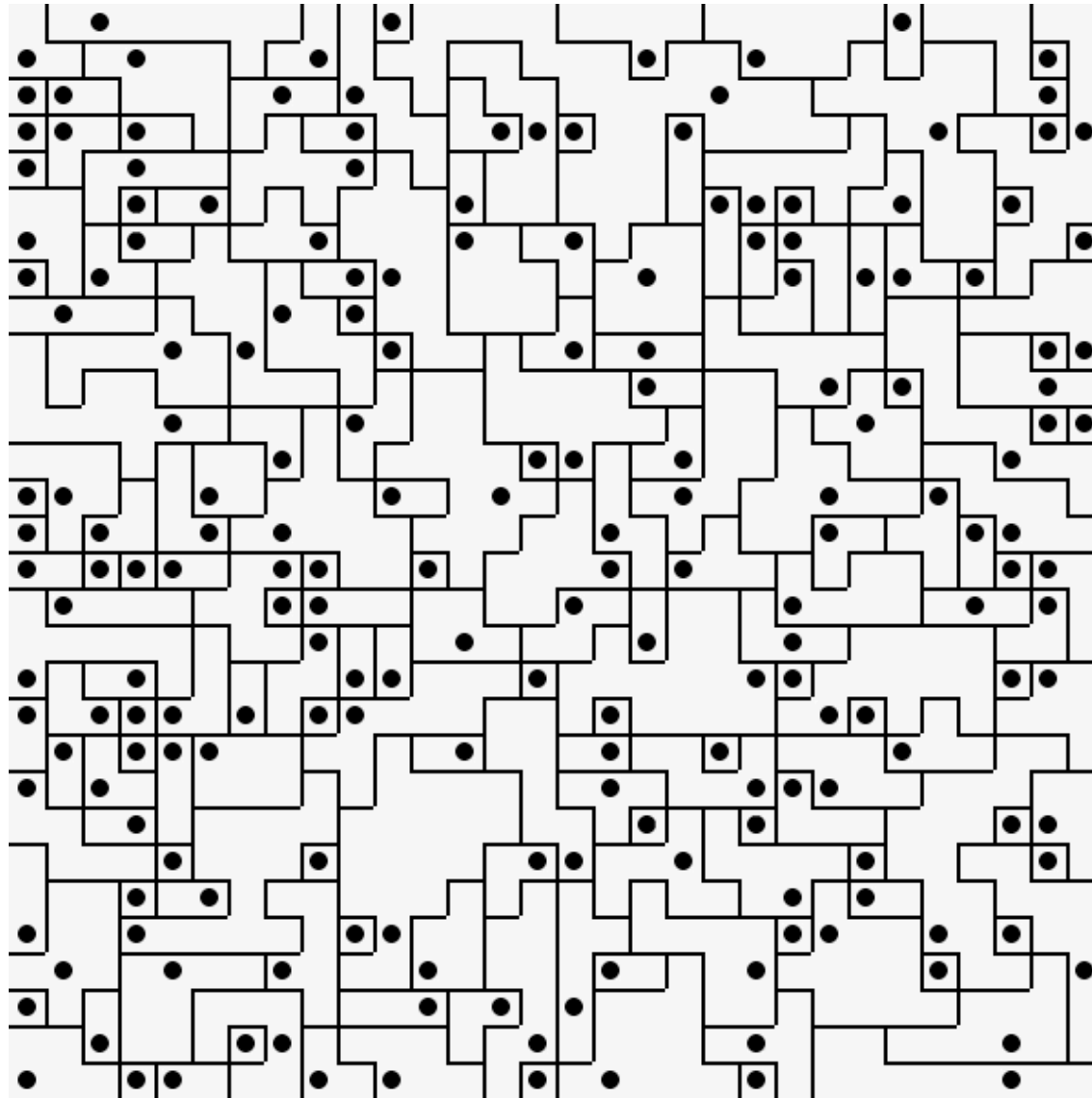


GeoSim

- GeoSim nutzt Repast, ein Java-Werkzeug
- Staaten sind hierarchische, begrenzte Akteure, die in einem dynamischen, gitter-basierten Netzwerk interagieren

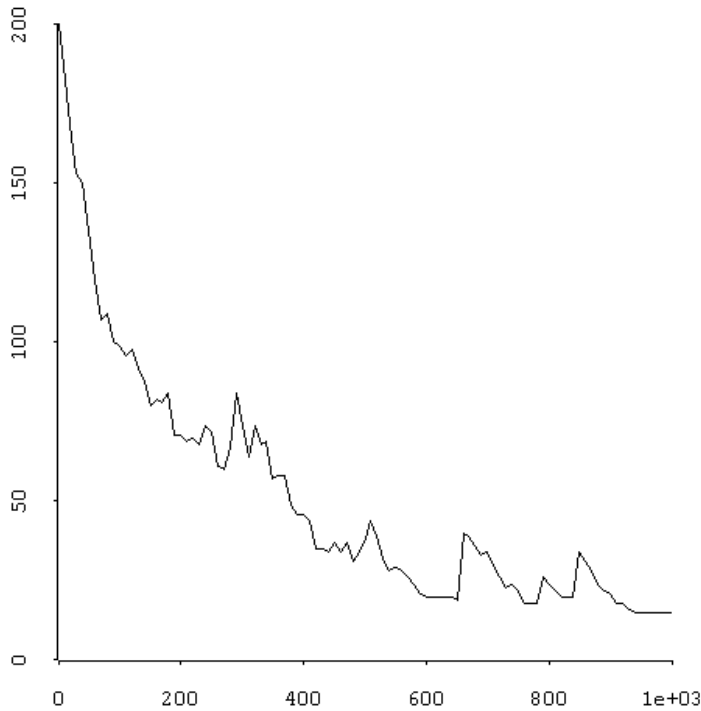


Vorführung 2



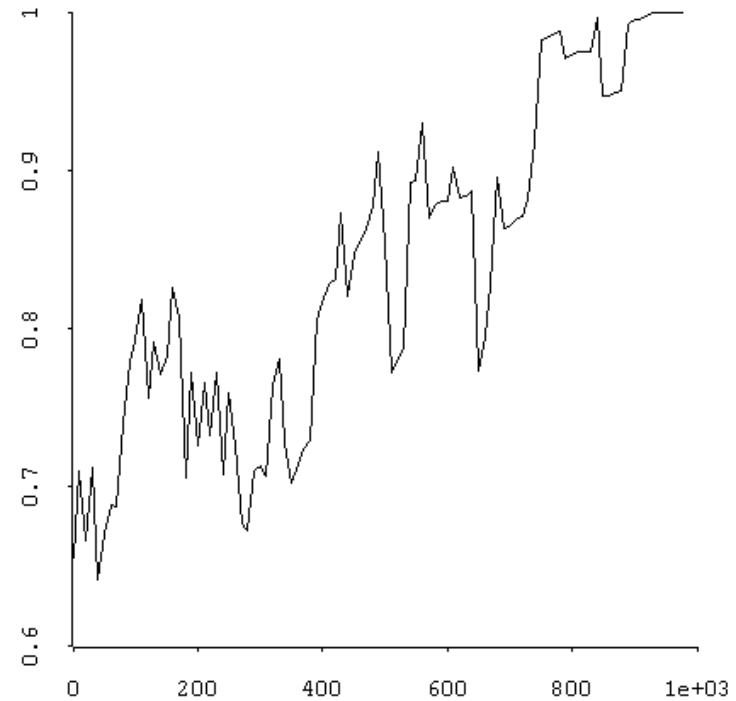
Emergente Ergebnisse

Anzahl der Staaten



Zeit

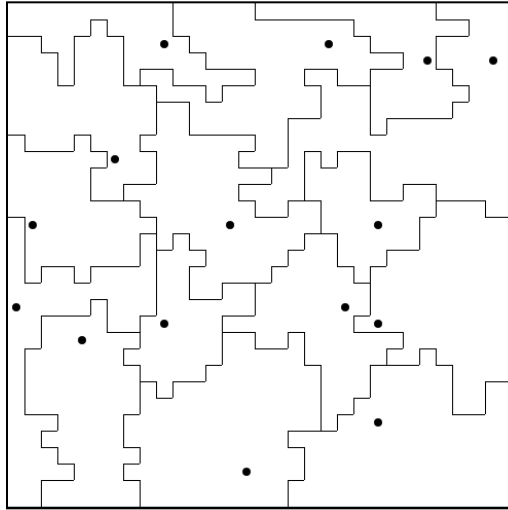
Anteil der sicheren Gebiete



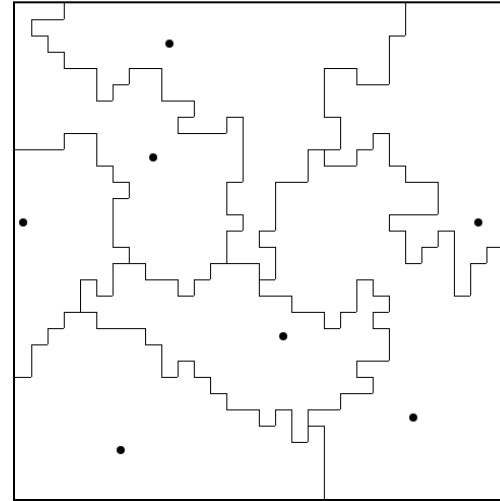
Zeit

Mögliche Equilibria

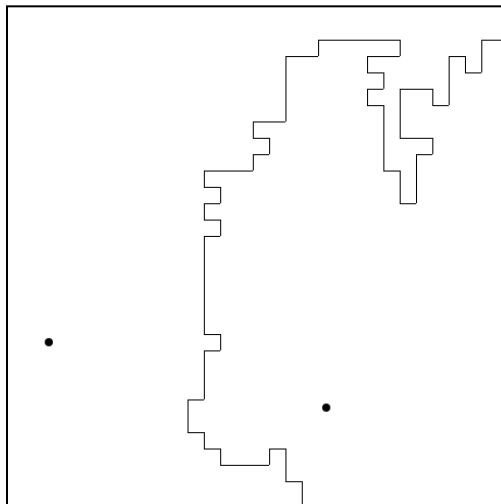
*Multipolarität
mit 15 Staaten
(Vorführung)*



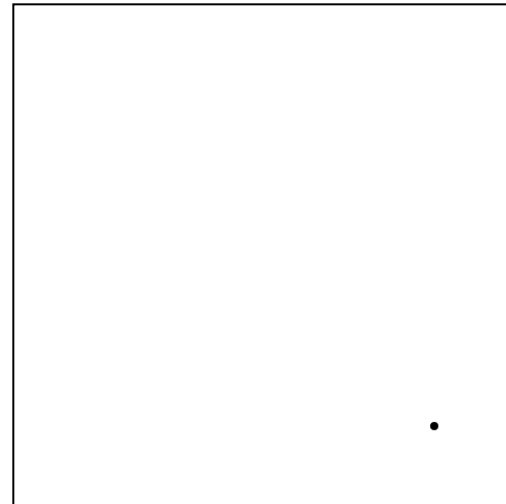
*Multipolarität
mit 7 Staaten*



Bipolarität



Unipolarität



Modeling conflict with ABM

Configurations

Processes

Qualitative
properties

Example 3.
Democratic peace

Example 4.
Emergence of the
territorial state

Distributional
properties

Example 2.
State-size
distributions

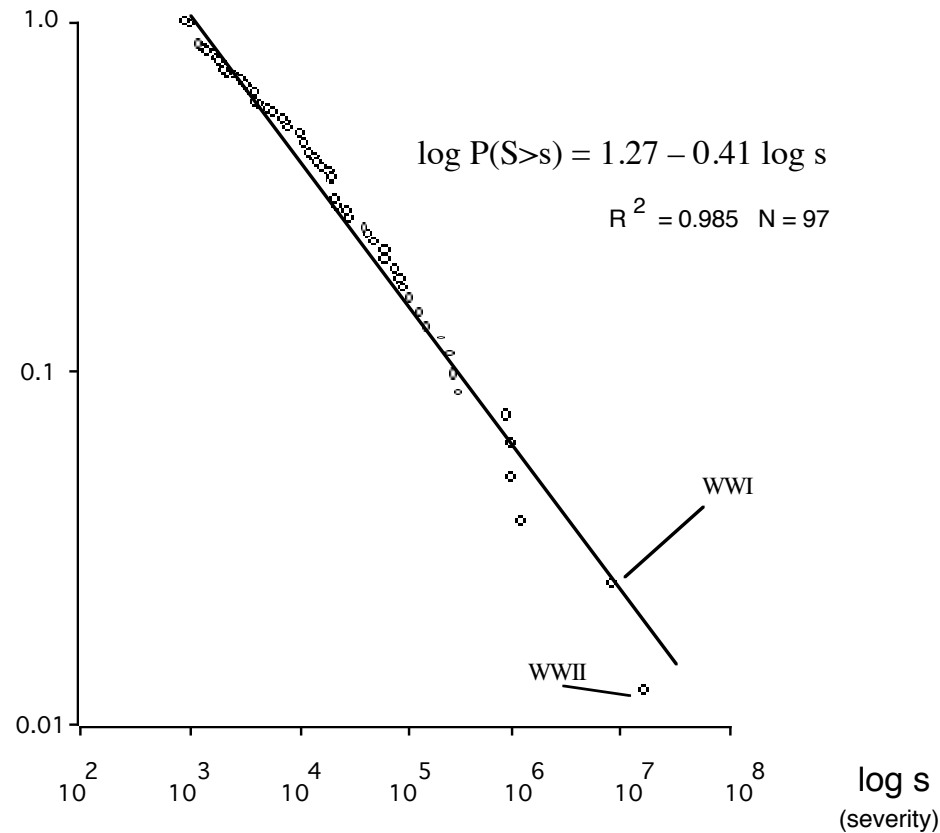
Example 1.
War-size
distributions

Cederman 2003. "Modeling the Size of Wars."
American Political Science Review 97:135-150.

Cumulative war-size plot, 1820-1997

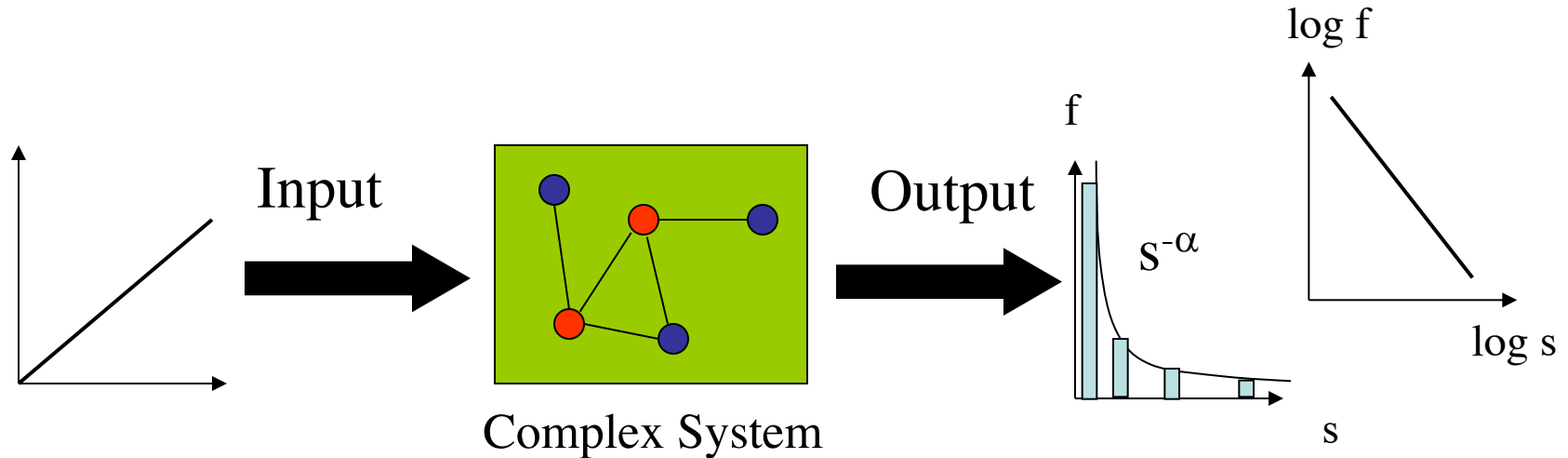
1

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



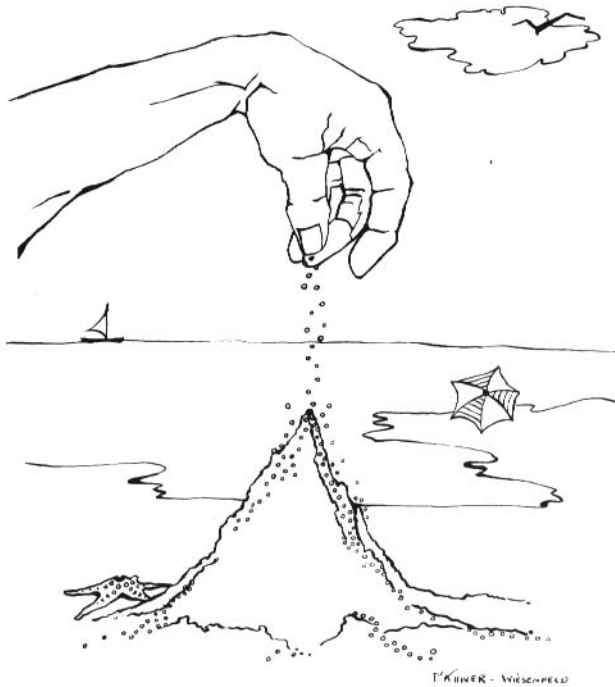
Data Source:
Correlates
of War
Project (COW)

Theory: Self-organized criticality

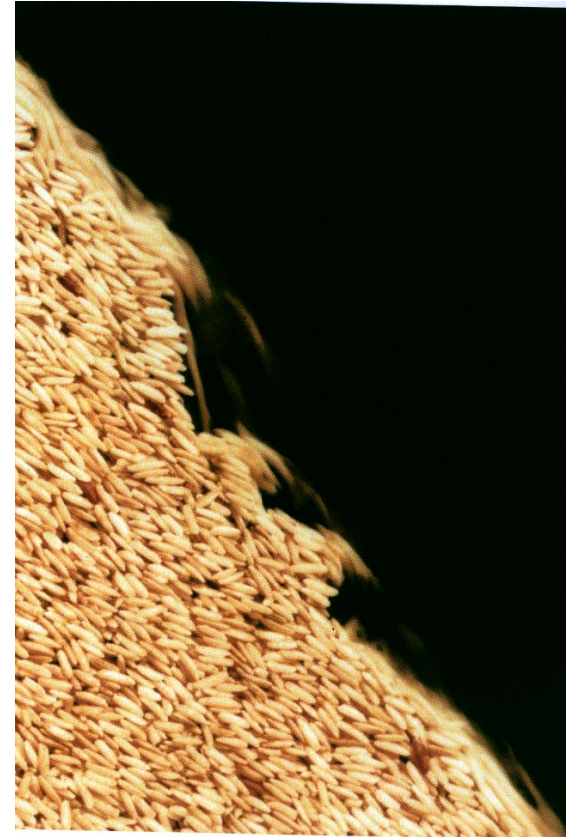


- Slowly driven systems that fluctuate around state of marginal stability while generating non-linear output according to a power law.
- Examples: sandpiles, semi-conductors, earthquakes, extinction of species, forest fires, epidemics, traffic jams, city populations, stock market fluctuations, firm size

Self-organized criticality

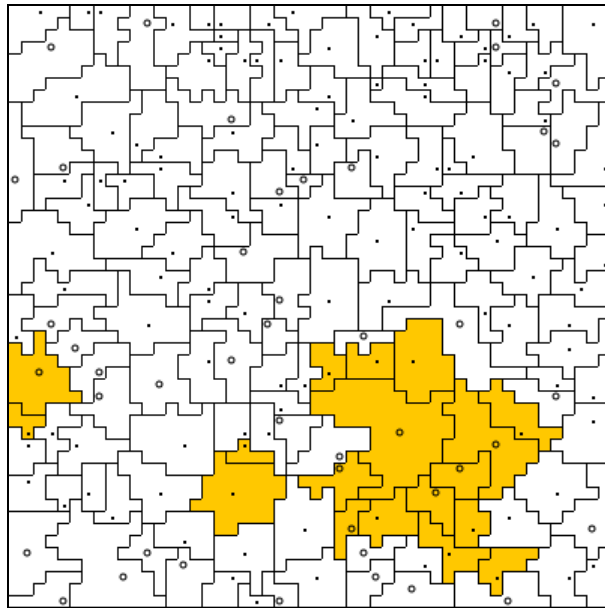


Per Bak's sand pile

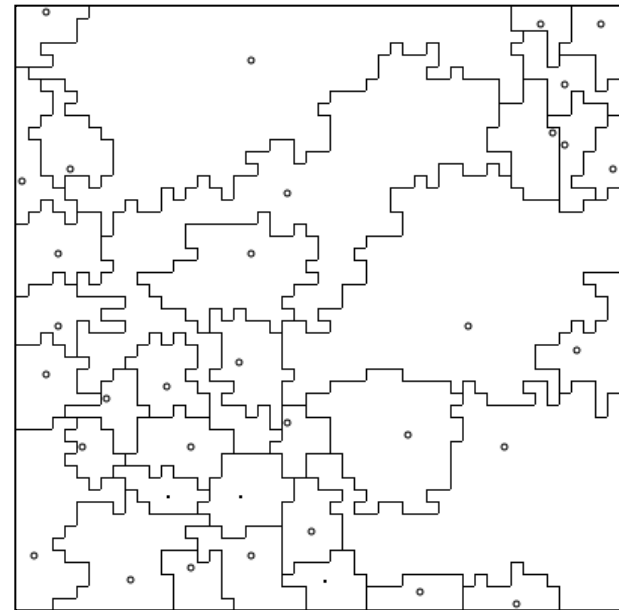


Power-law distributed avalanches in a rice pile

War clusters in Geosim

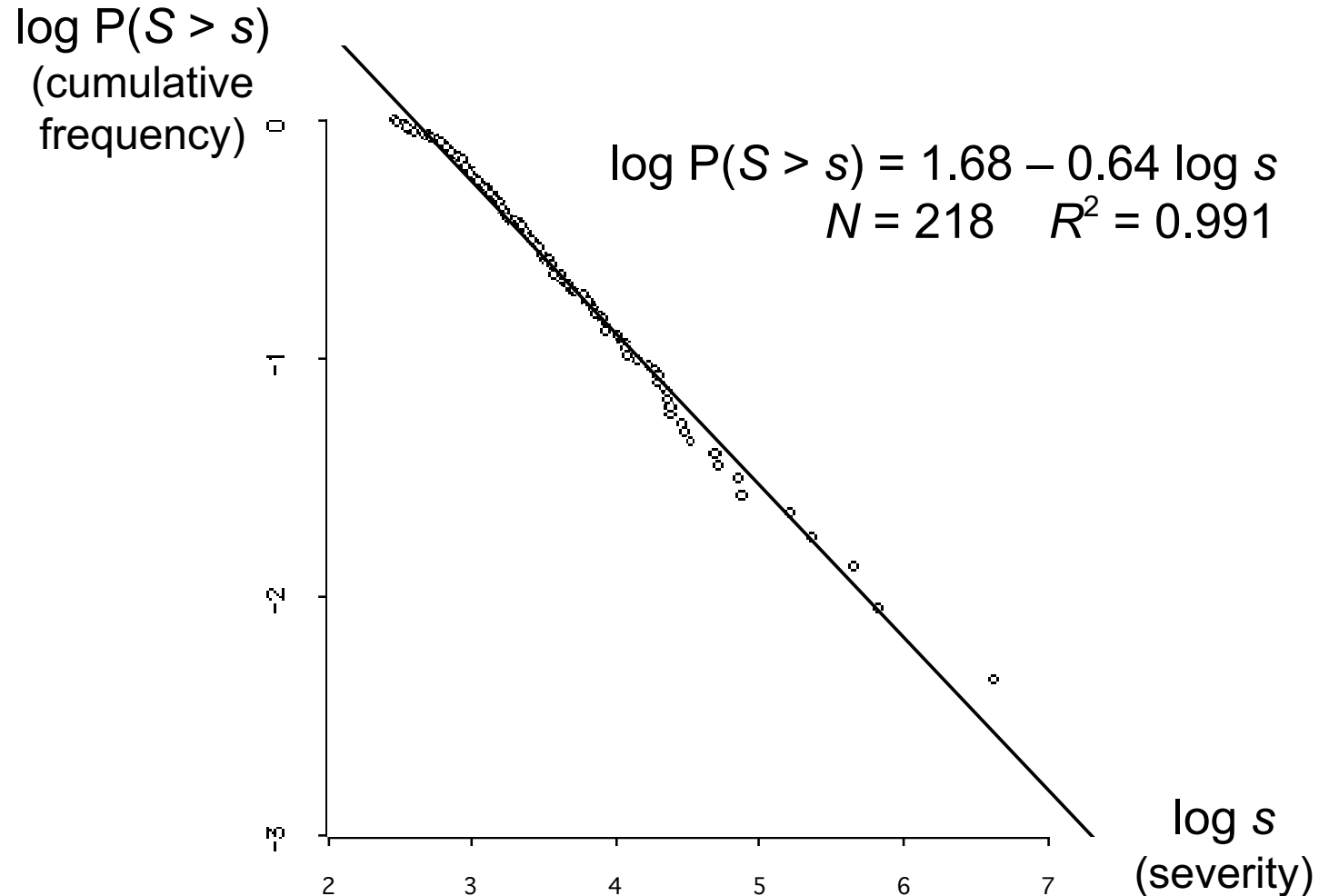


t = 3,326



t = 10,000

Simulated cumulative war-size plot



See “Modeling the Size of Wars” *American Political Science Review* Feb. 2003

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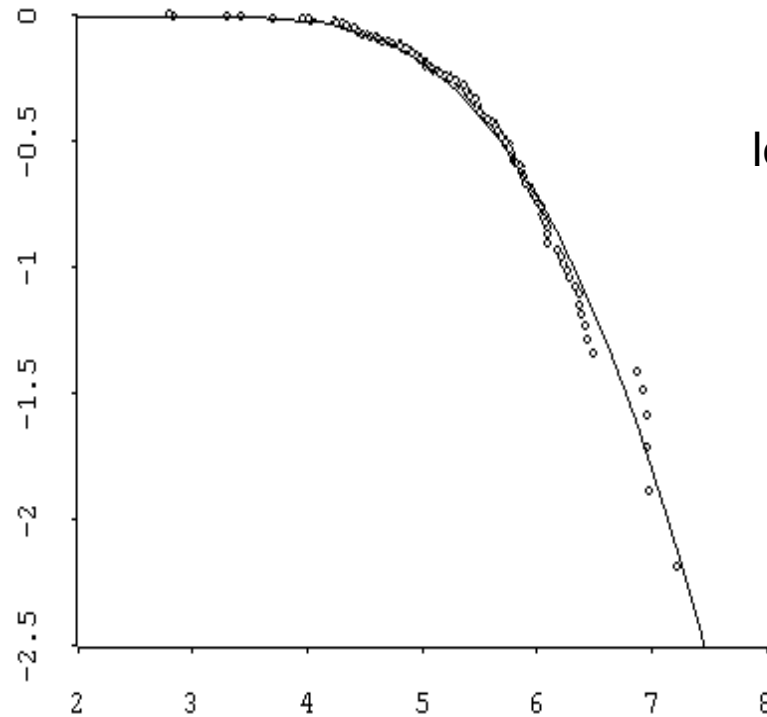
Example 2.
State-size
distributions

Example 1.
War-size
distributions

Cederman 2003. "Explaining State Sizes: A Geopolitical Model."
Proceedings of Agent 2003, eds. Macal, North & Sallach. Argonne.

2. Modeling state sizes: Empirical data

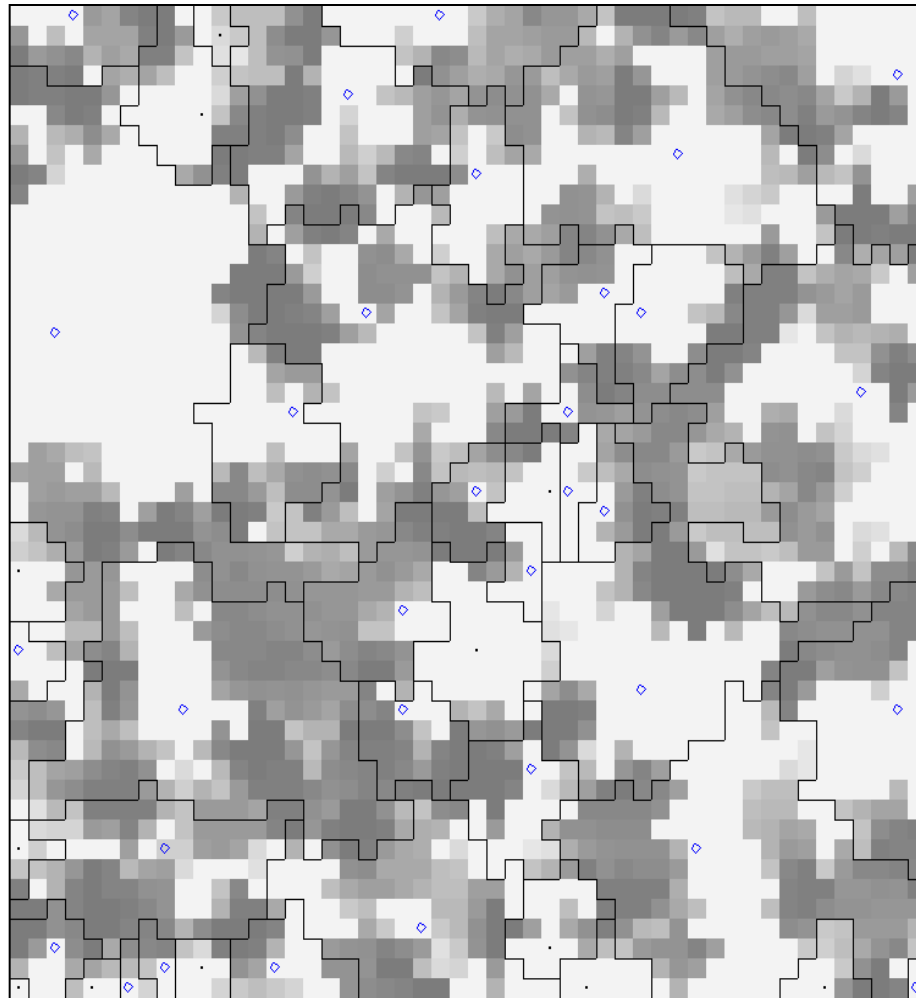
$\log \Pr (S > s)$
(cumulative frequency)



$\log S \sim N(5.31, 0.79)$
MAE = 0.028

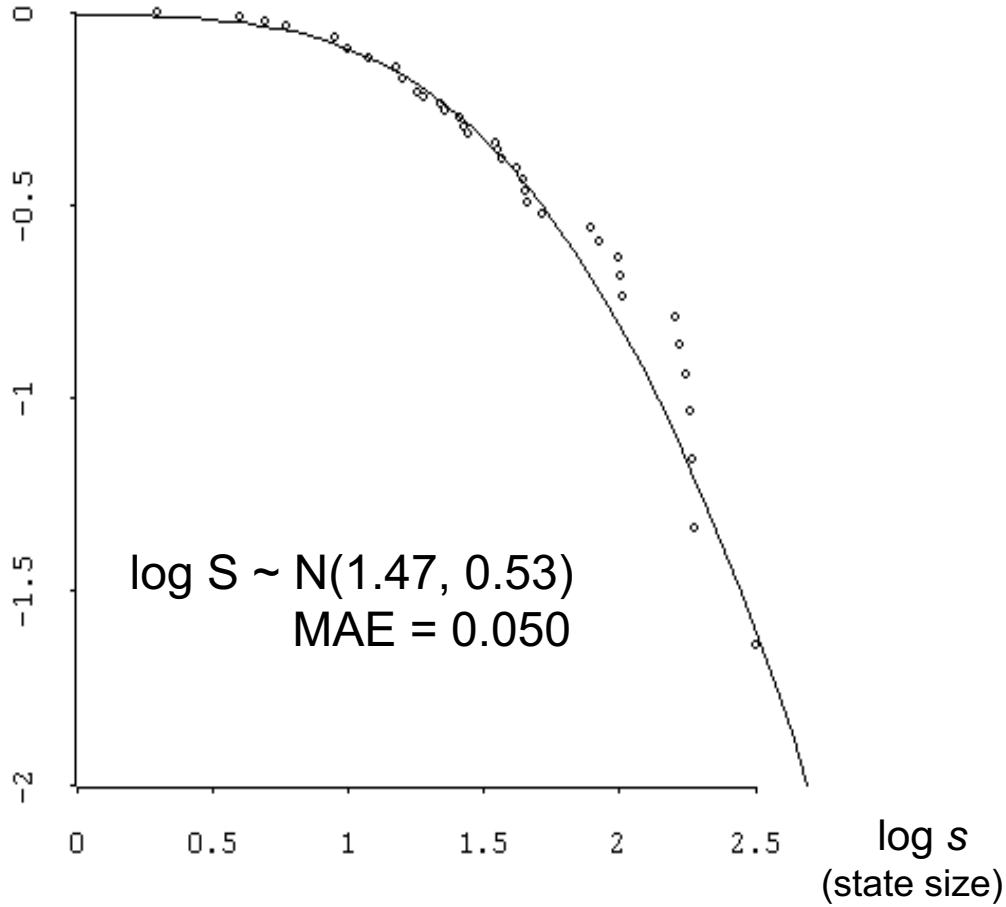
Data: Lake et al.

Simulating state size with terrain



Simulated state-size distribution

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



Modeling conflict with ABM

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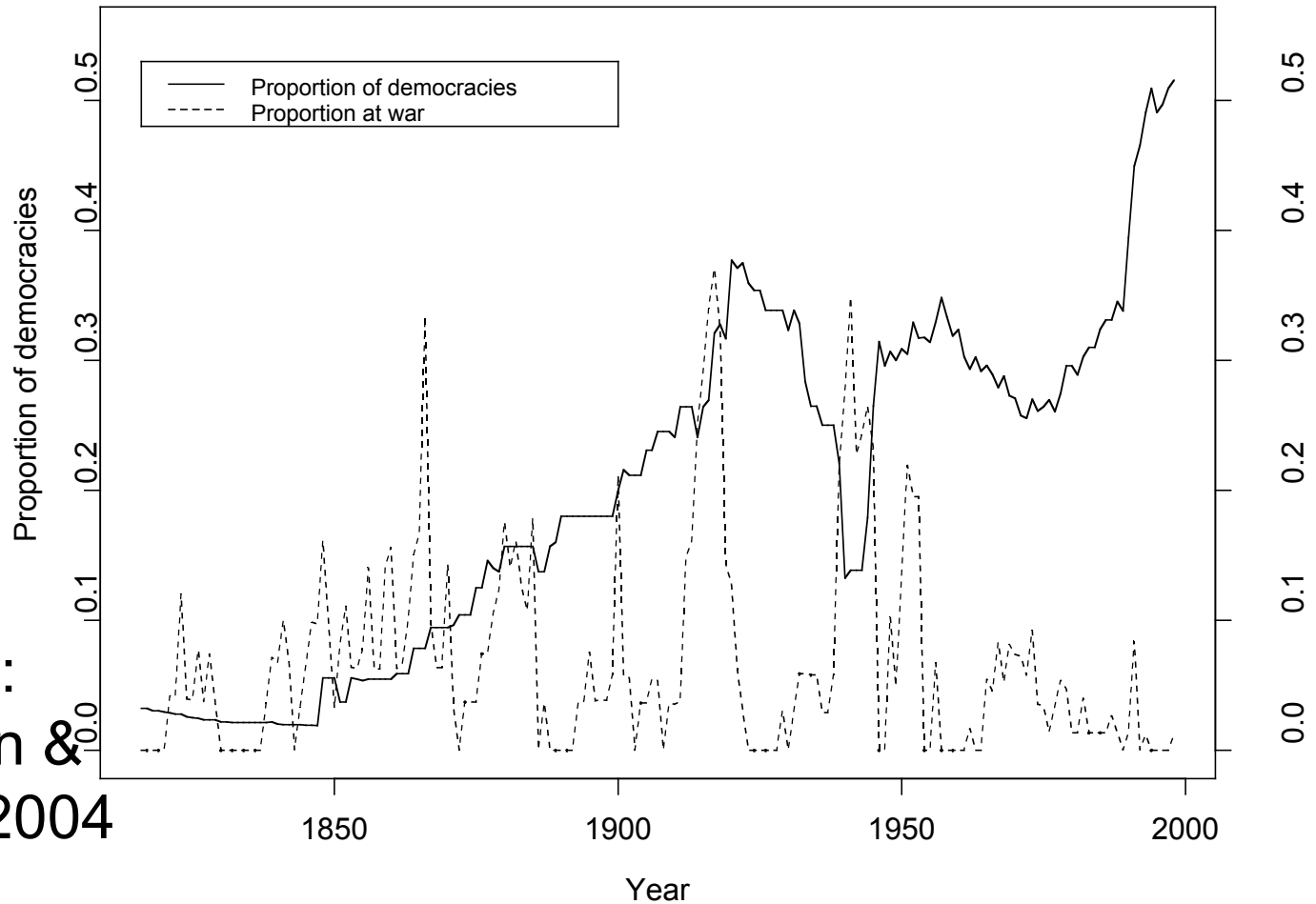
Distributional
properties

Example 2.
State-size
distributions

Example 1.
War-size
distributions

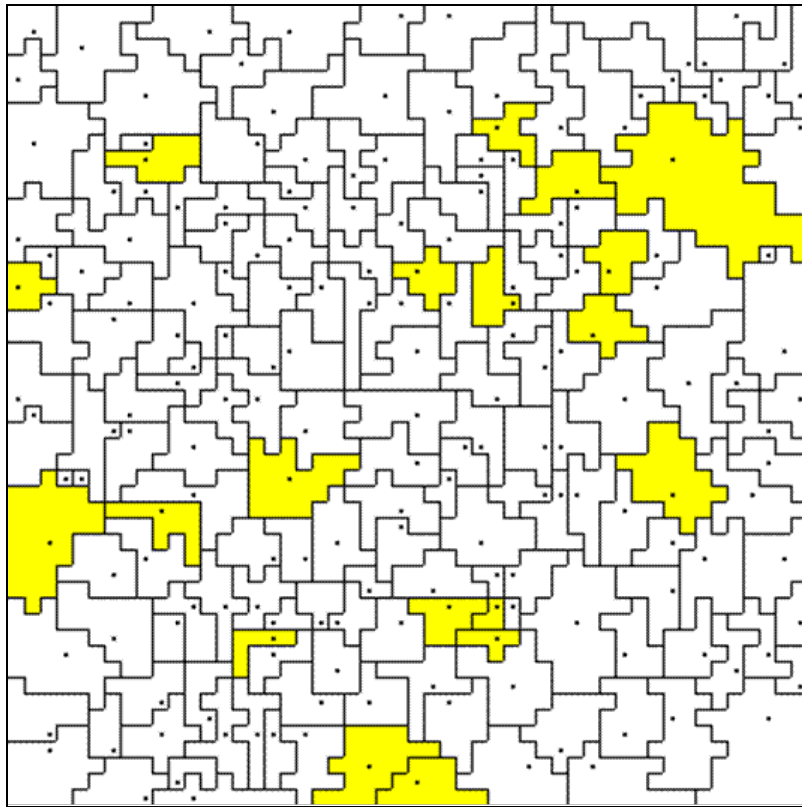
Cederman, L-E & K S Gleditsch. 2004. "Conquest and Regime Change"
International Studies Quarterly 48:603-629.

Simulating global democratization

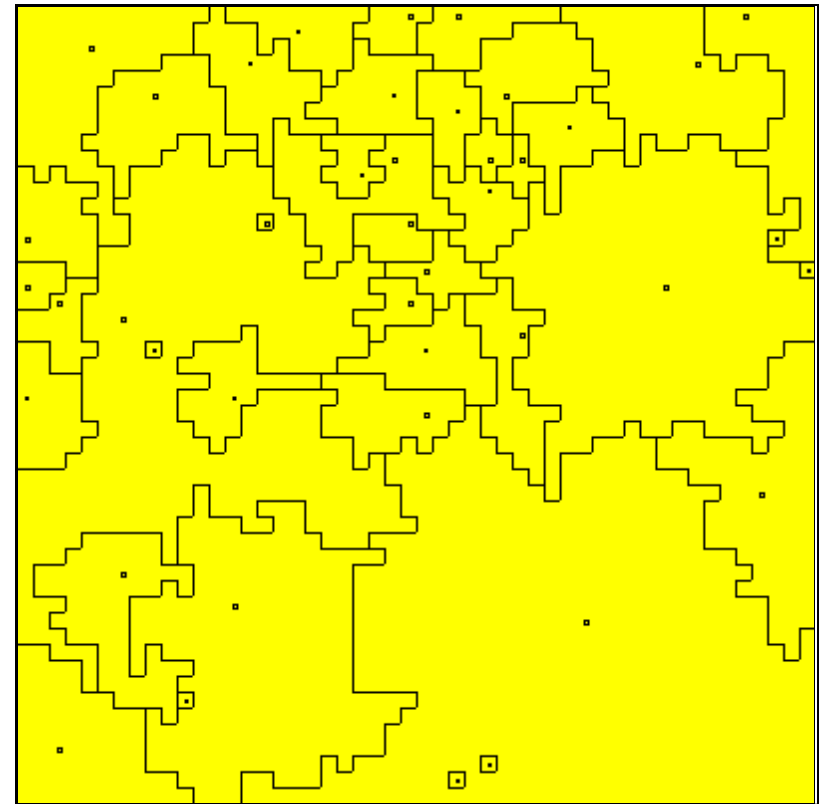


Source:
Cederman &
Gleditsch 2004

A simulated democratic outcome

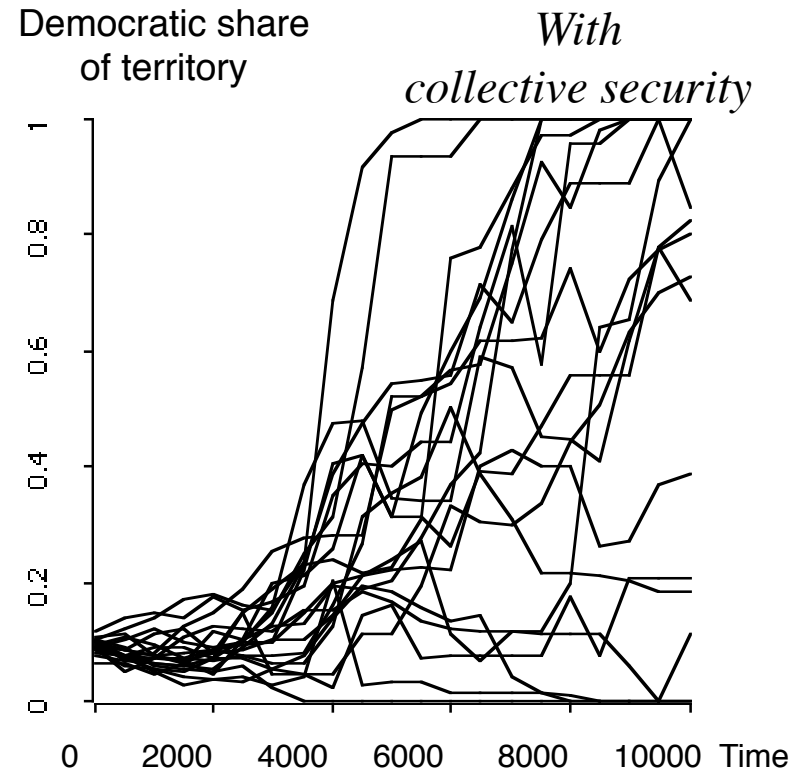
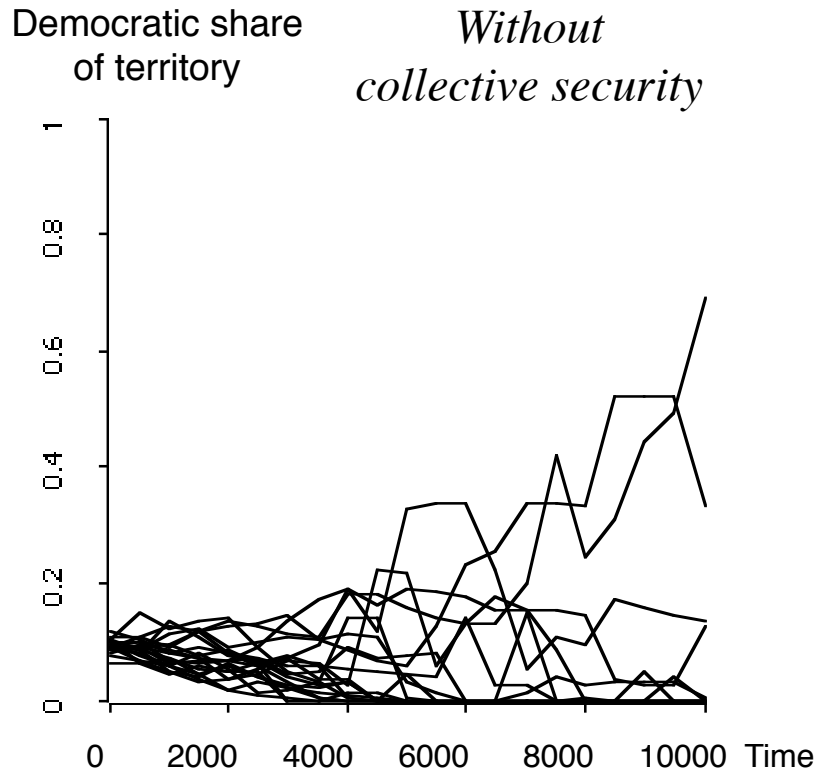


$t = 0$



$t = 10,000$

Replications with regime change



Modeling conflict with ABM

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properties

Example 3.
Democratic peace

Example 4.
Emergence of the
territorial state

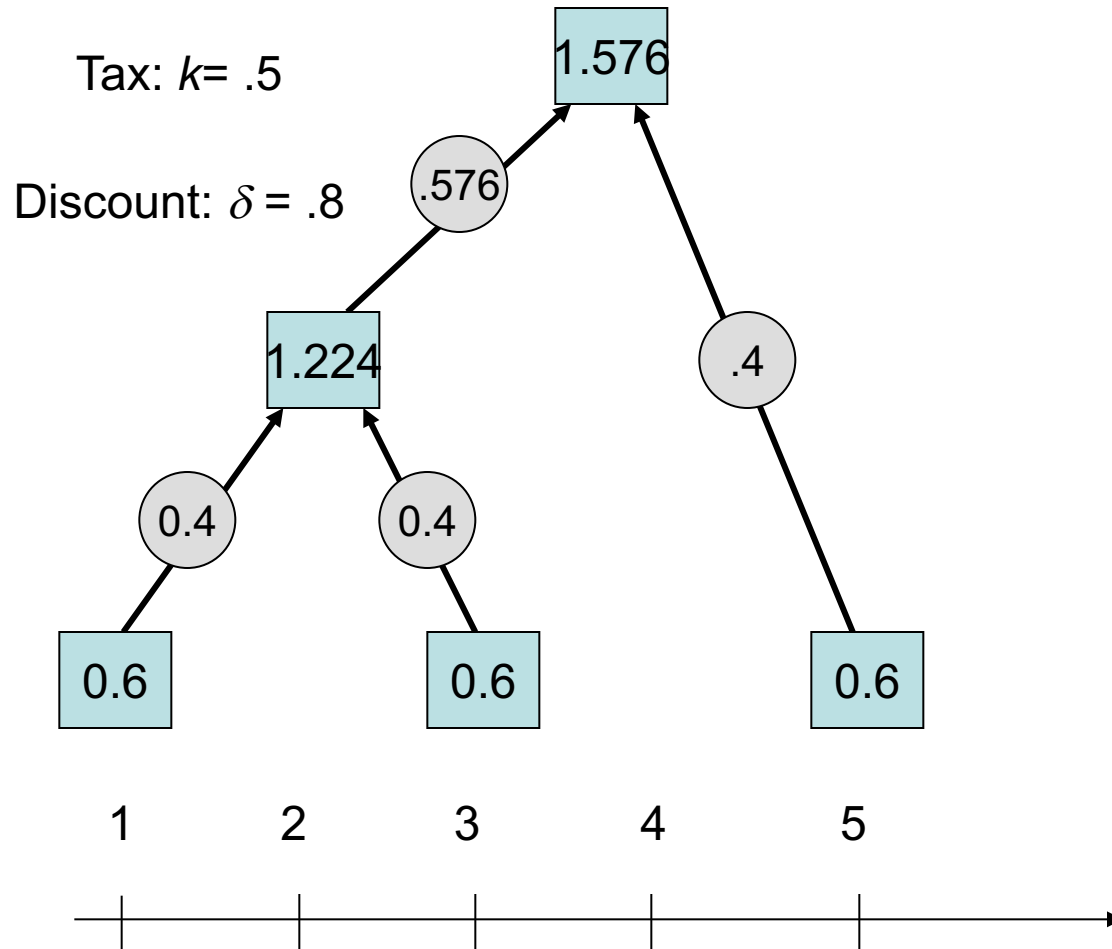
Distributional
properties

Example 2.
State-size
distributions

Example 1.
War-size
distributions

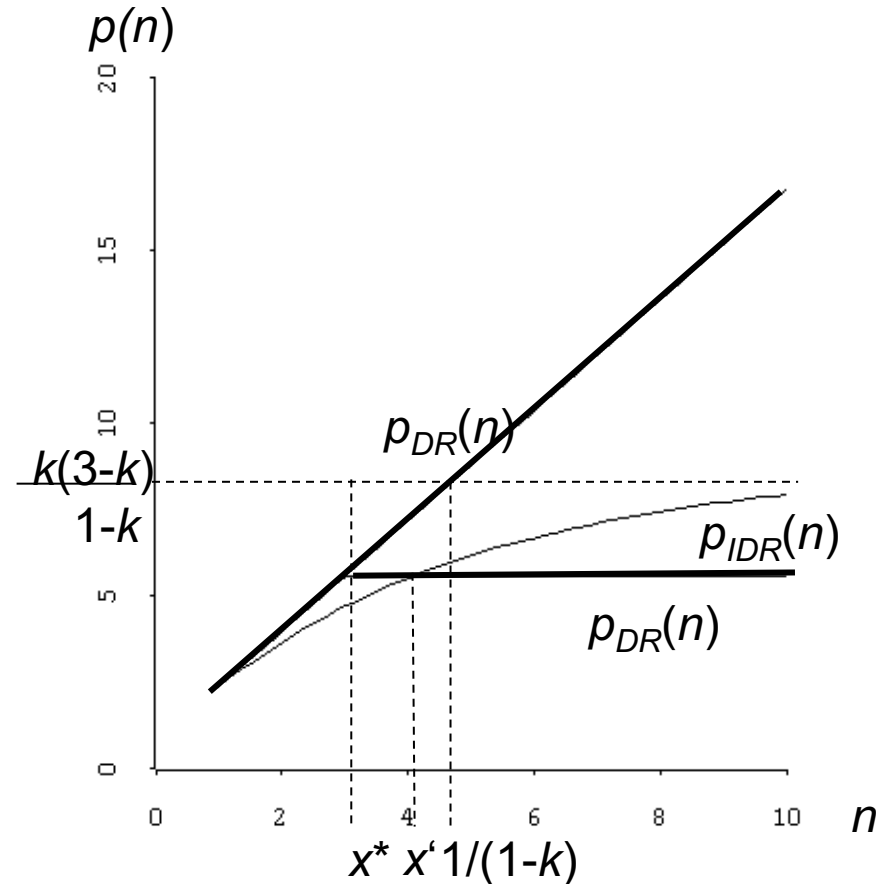
Cederman & Girardin 2010. "Growing Sovereignty"
International Studies Quarterly 54: 27-48.

Taxation in a linear state

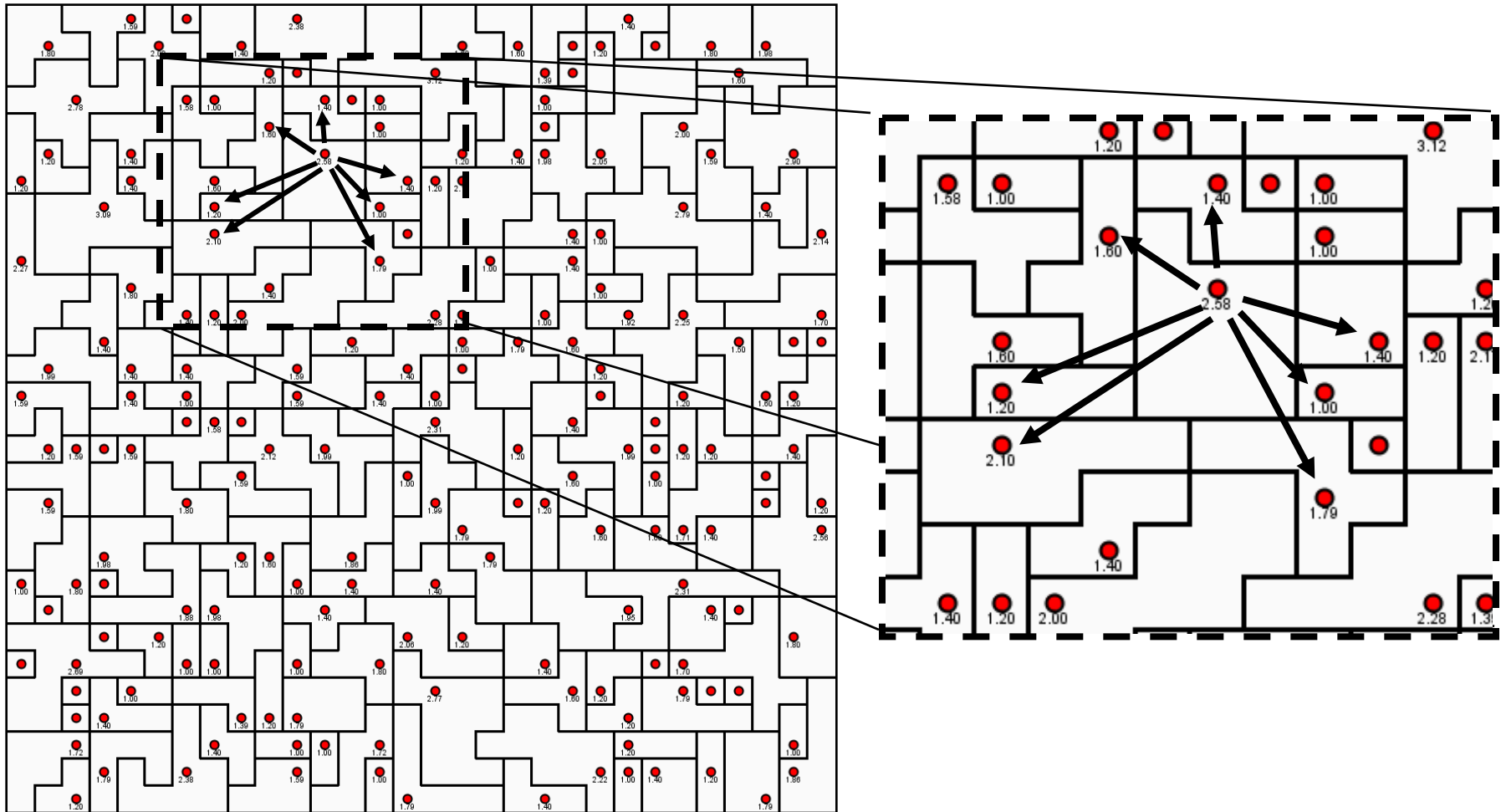


Results from the linear model

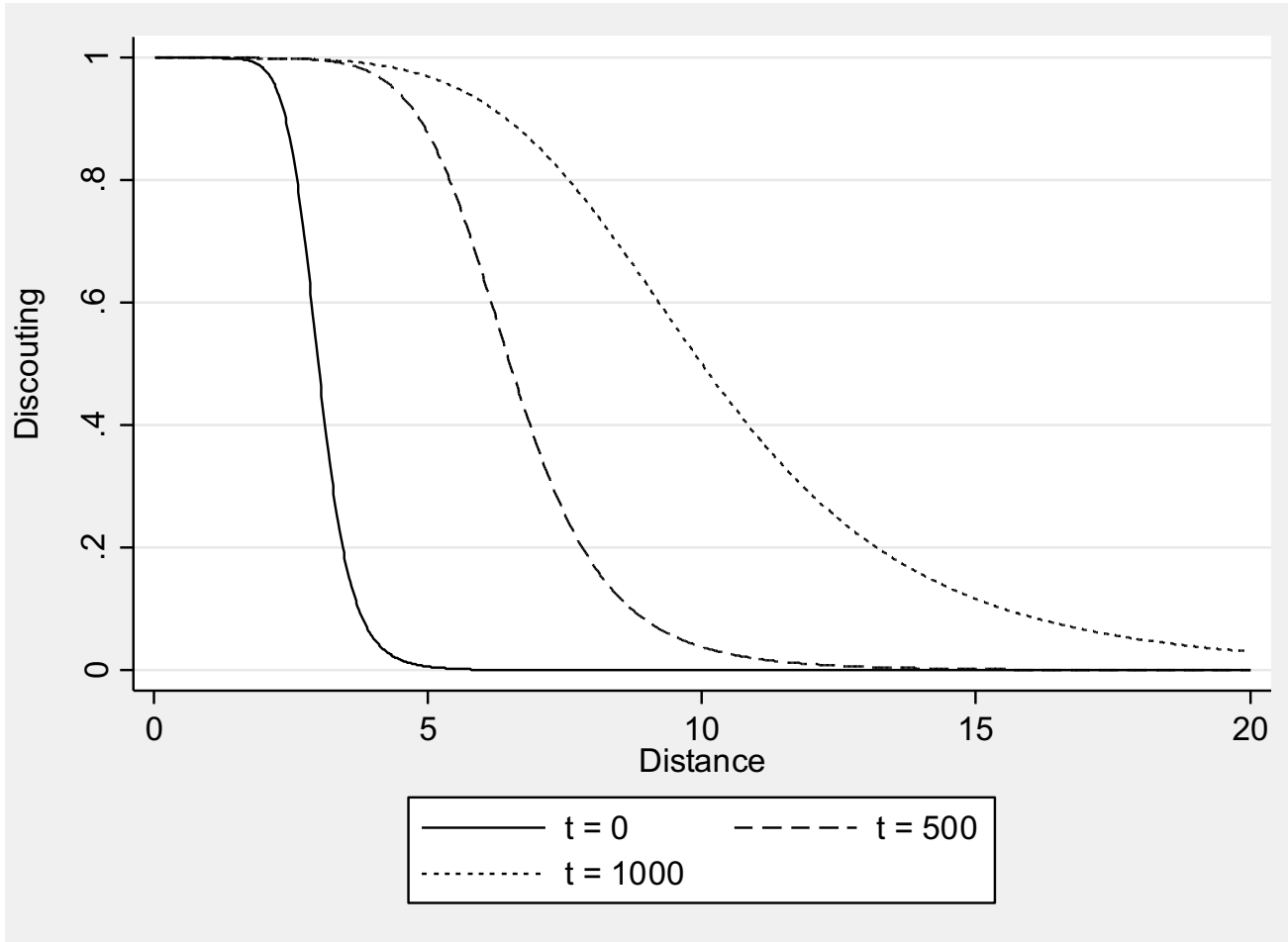
- **Proposition 1.**
Assuming exponential decay, direct rule is always more efficient
- **Proposition 2.**
Assuming a step function, indirect rule is more efficient for low threshold values x^*



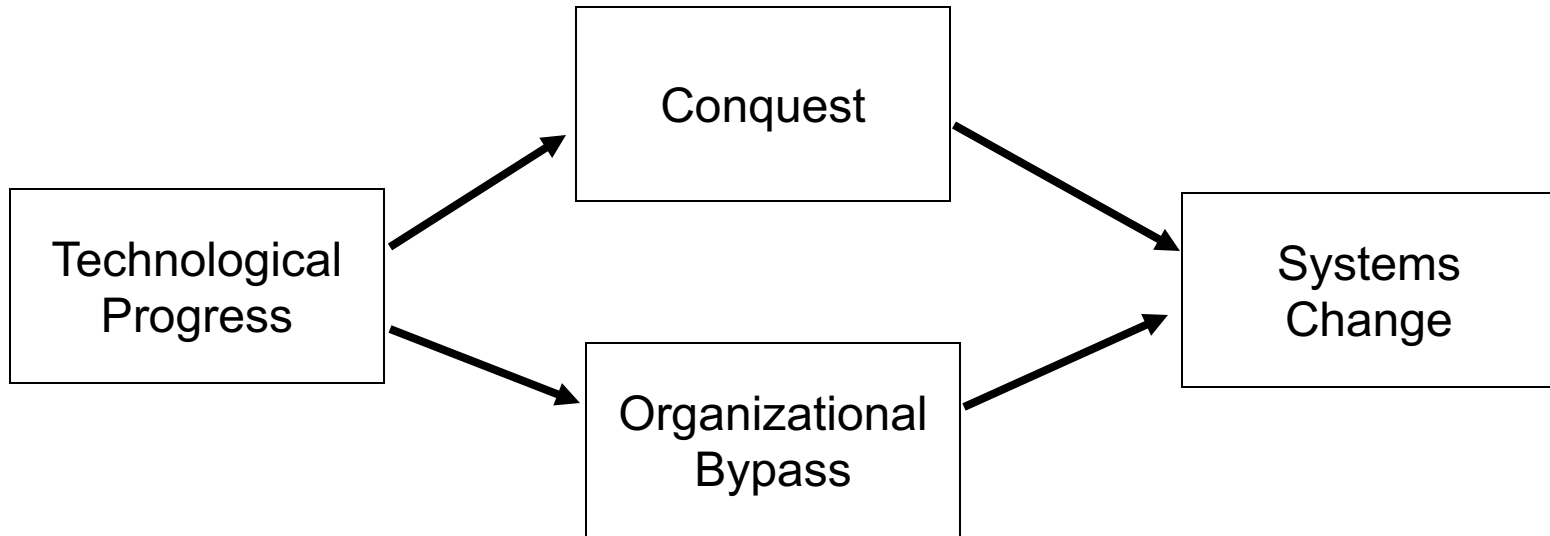
The initial state of *OrgForms*



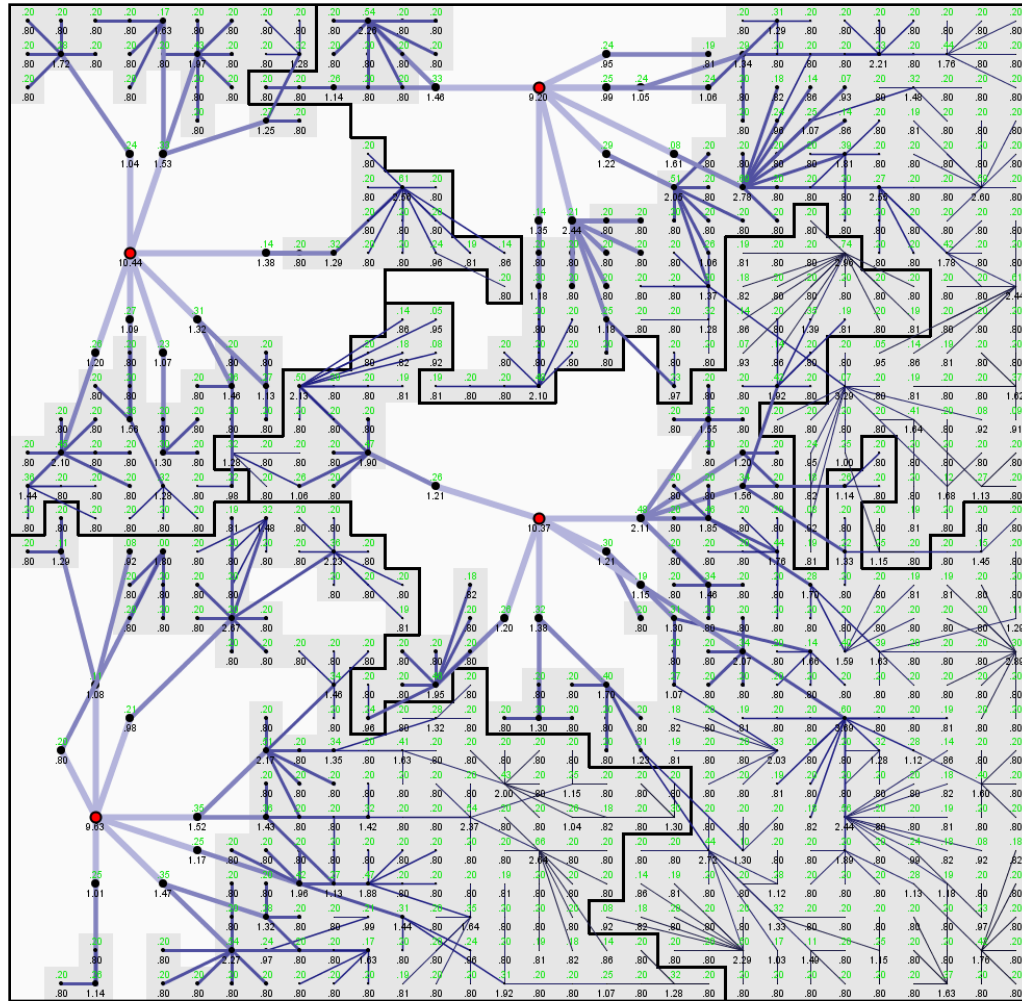
Modeling technological change



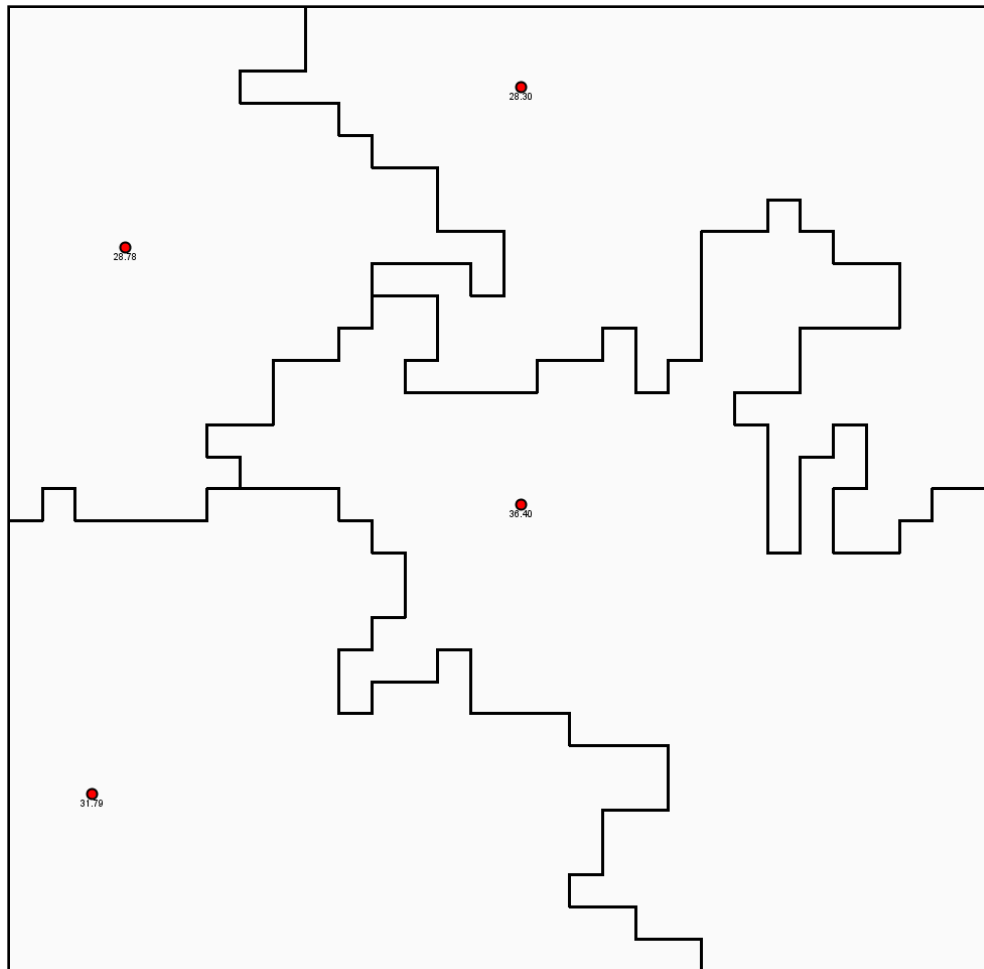
OrgForms: A dynamic network model



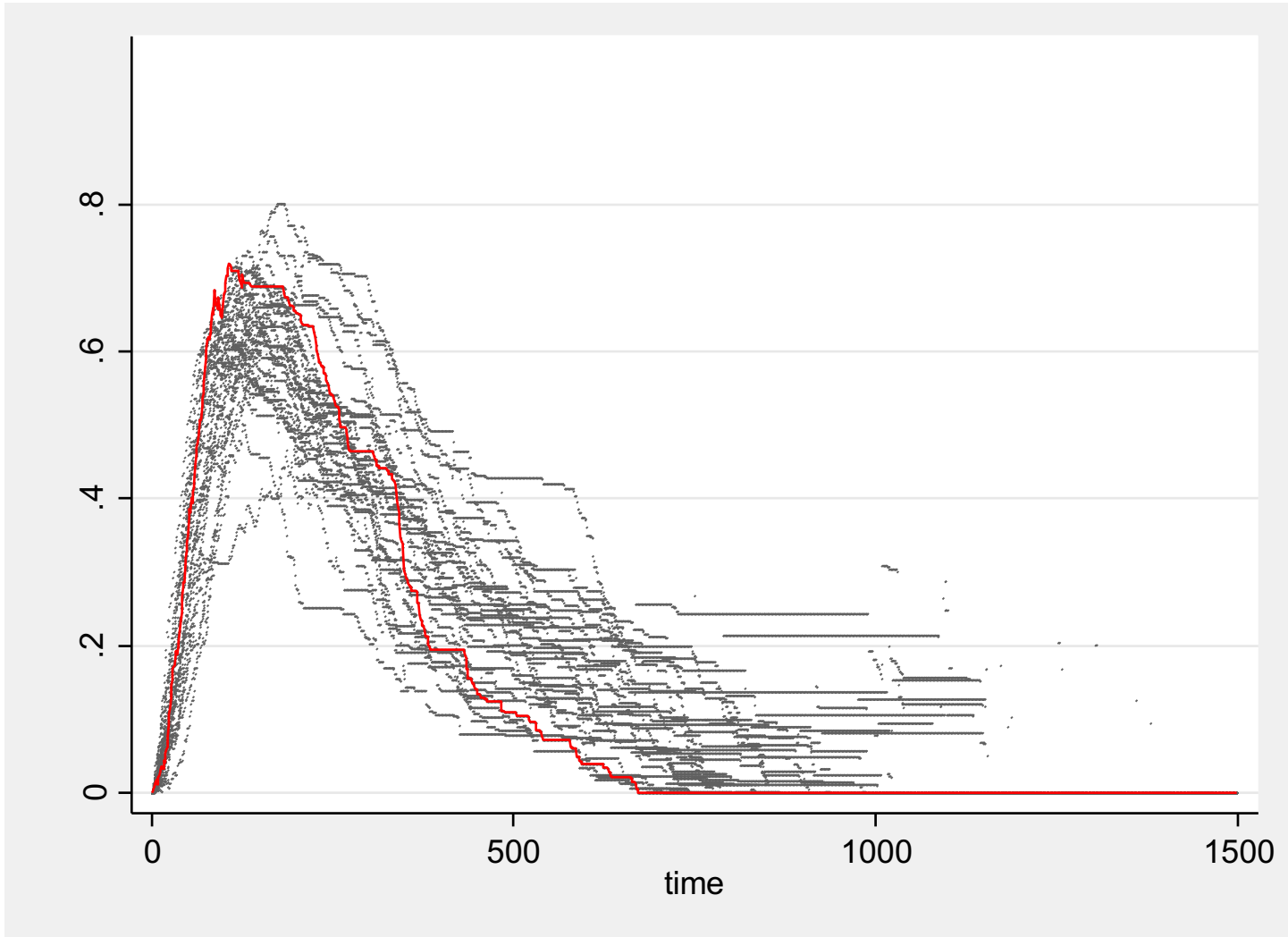
Indirect rule in the “Middle Ages”



Direct rule in the modern system



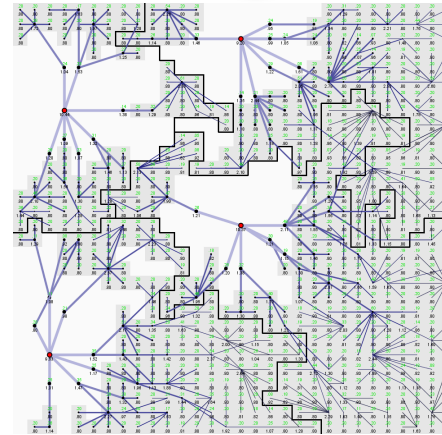
Replications with moving threshold and slope



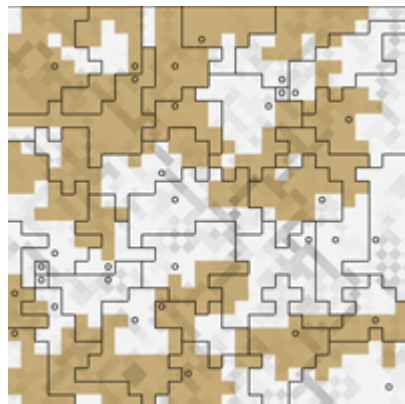
Exploring geopolitics using agent-based modeling



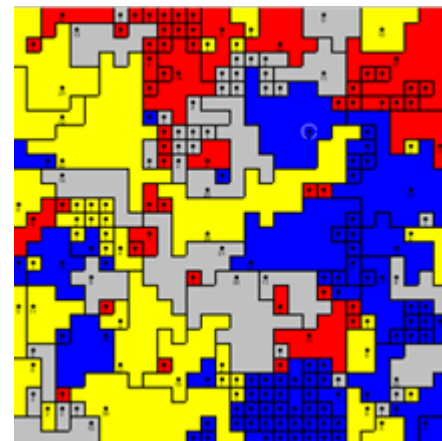
GeoSim 0



OrgForms



GeoSim 4



GeoContest

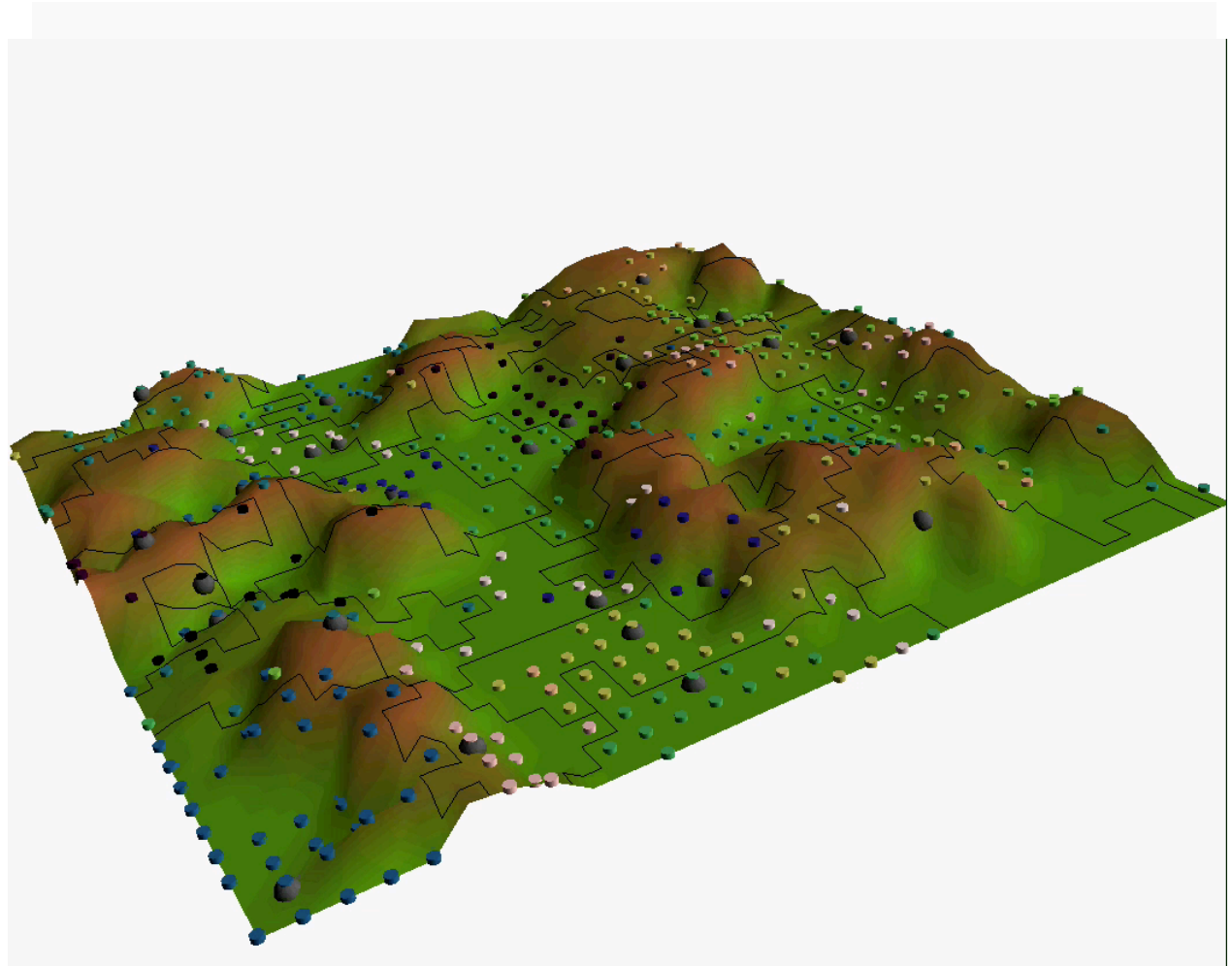
Toward more realistic models of civil wars

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

Step I: Nationalist insurgency model

4

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



In Order, Conflict, and Violence, eds. Kalyvas, Shapiro & Masoud. CUP, 2008.