Population Dynamics
in the Schelling model of segregation

学术论文

ISCAS

★ *Minority population in 1D Schelling model of segregation J.Stat.Phys.173 (2018)*

★ *Digital morphogenesis via Schelling segregation. Nonlinearity 31 (2018)*

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Background

Models of self-organization explain how a population of agents or particles may organize itself forming patterns or large homogeneous clusters. Variants include the Ising model from physics and the Schelling models of segregation from social sciences. While such models have been extensively studied, unperturbed (or noiseless) versions have largely resisted rigorous analysis, with most results in the literature pertaining models in which noise is introduced, so as to make them amenable to standard techniques from statistical mechanics.

The model

Two populations of agents (two colors) are randomly distributed in the 1D or 2D space and move in order to have more agents of their own color in their neighborhood.

Goal

Dynamics drives the system into equilibrium state and the goal is to determine the degree of fragmentation of the two populations in this final state, in terms of the parameters.

Dynamics

An agent desires to move to a better position only if the percentage of agents of its own color in its current neighborhood is $< \tau$.

*Simulations showing the process of **formation** of various degrees of segregation patterns.*
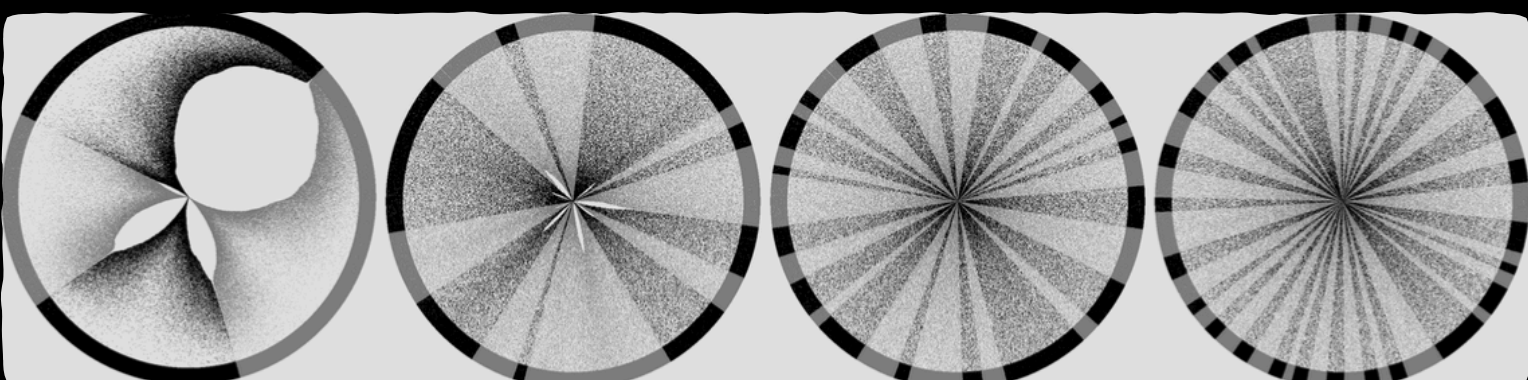
Graphical simulations

Outer circle shows the fragmentation of the two populations (two colors) at the final state. The pictures above show the uniform case (equal populations) for intolerance rising from 34% to 50%.

Time evolution

Colored dots in the interior of the circle depict new arrivals at a time of the process which is proportional to its distance from the center.

Outcome for uniform populations

Intolerance	0-35%	35-49%	50%	51-100%
Segregation	Negligible	Exponential	Polynomial	Complete

Phase transitions are expressed in terms of size of expected monochromatic area as a function of the size of the neighborhood

Methodology for the Uniform case

★ Fluid limits of stochastic equations

★ Firewall dynamics and symmetry
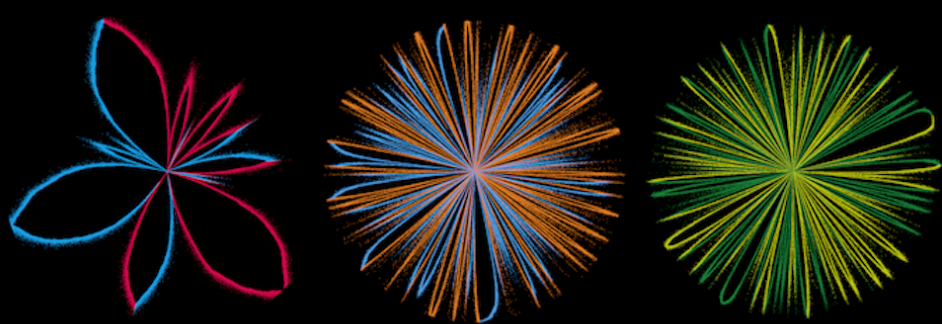
★ Animations in C++ & GLUT/OpenGL
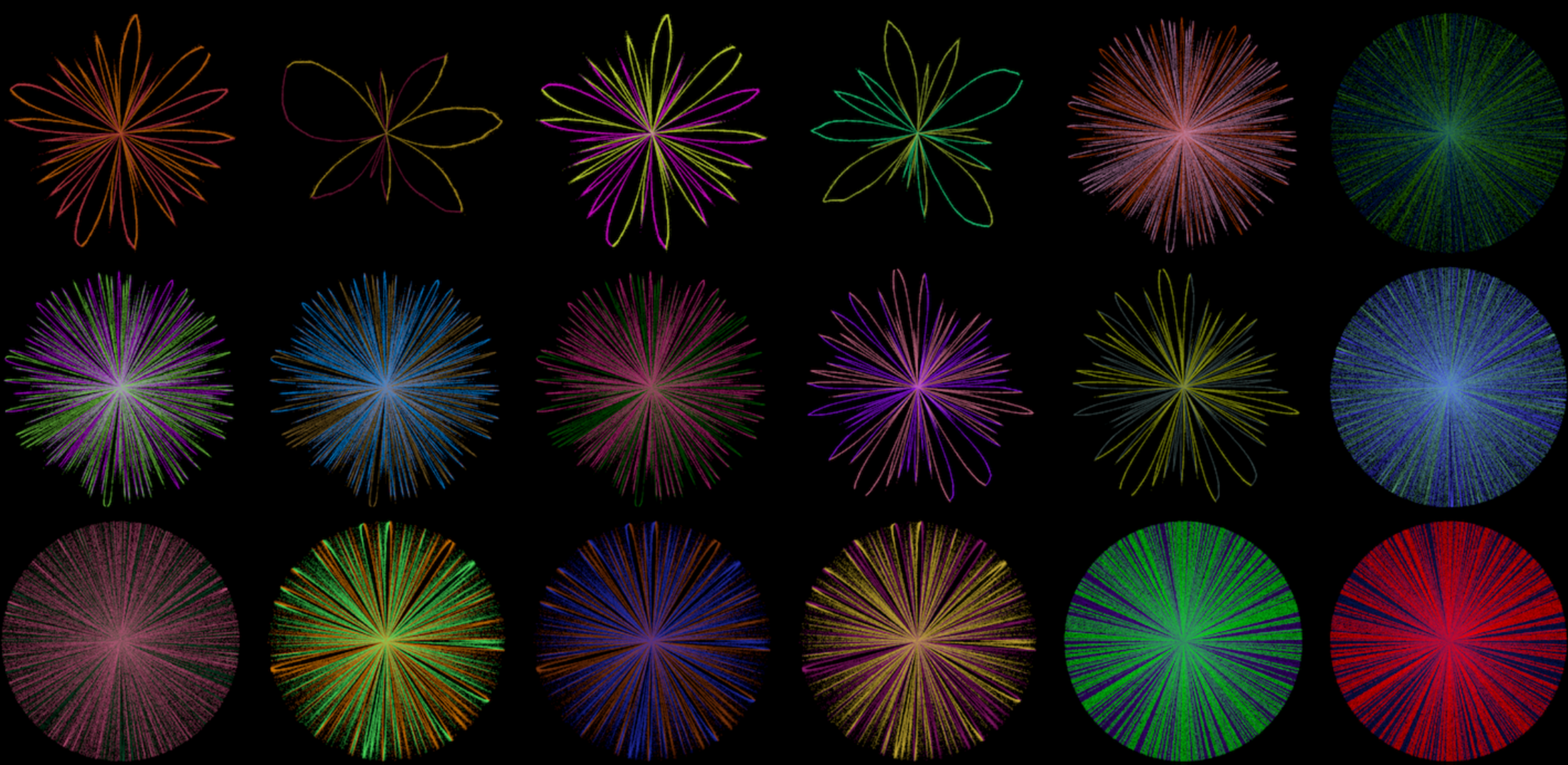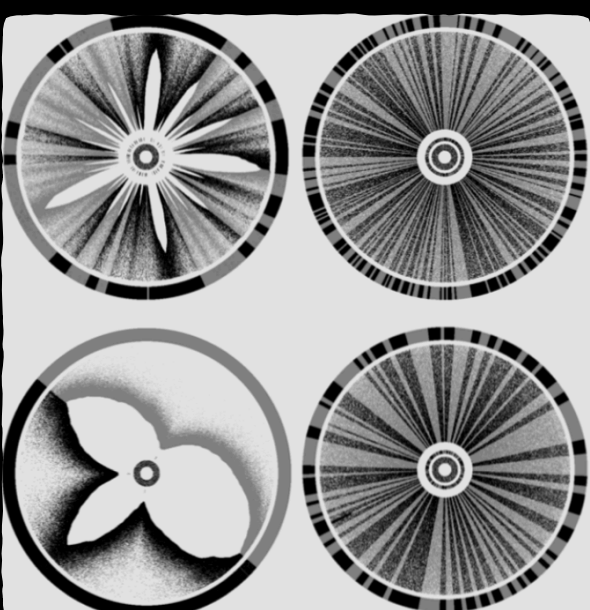
Flowers of segregation

Various of patterns emerge in simulations of the model for different parameters, which indicate cascades of massive population movements driving the race to the equilibrium.

Parameters

τ	Acceptable % of same-type neighbors
ρ	Percentage of minority population

Outcome in the presence of a minority

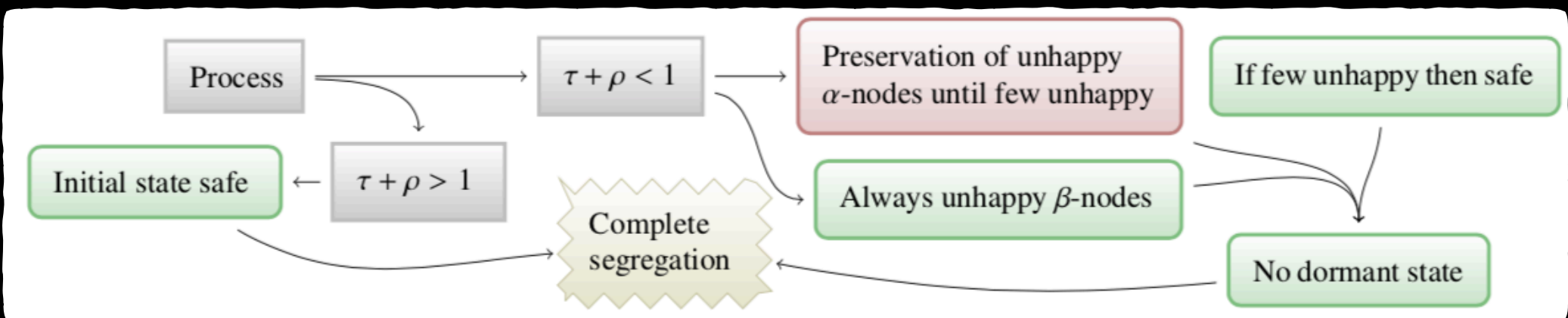| Intoler./minority	**τ**: 0-50% / **ρ**: 0-25%	**τ**: 51-100% / **ρ**: 0-50%
Segregation	Negligible	Complete

Methodology for the minority case

★ Combinatorial transition analysis

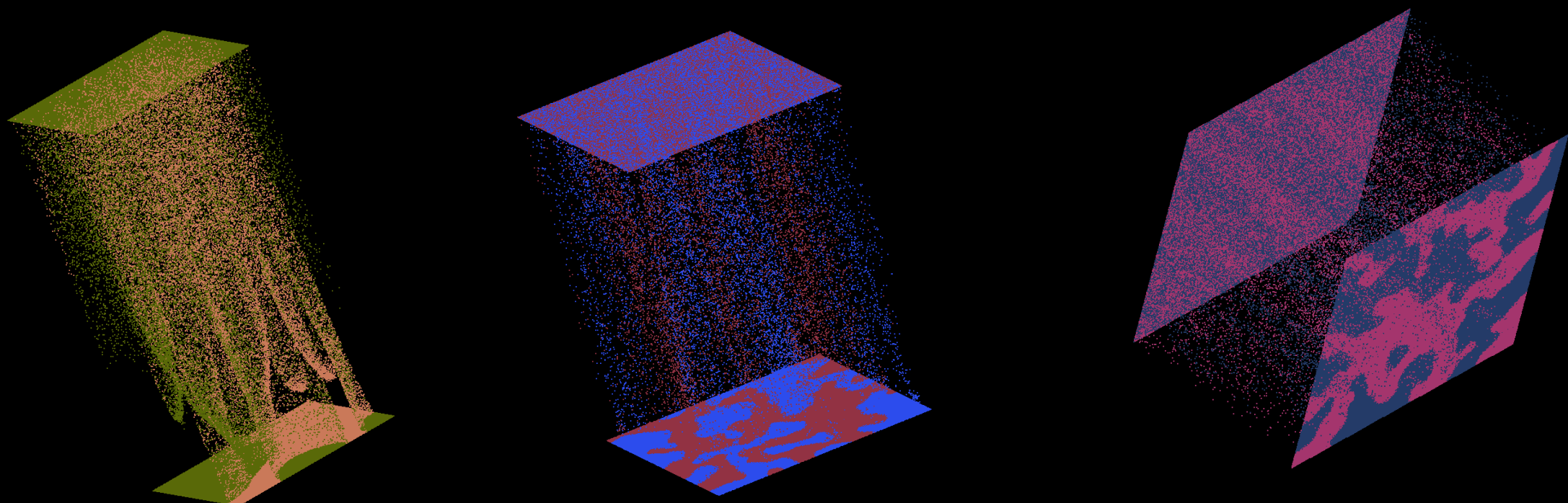★ Asymptotic analysis of probability

★ Non-measurable martingales
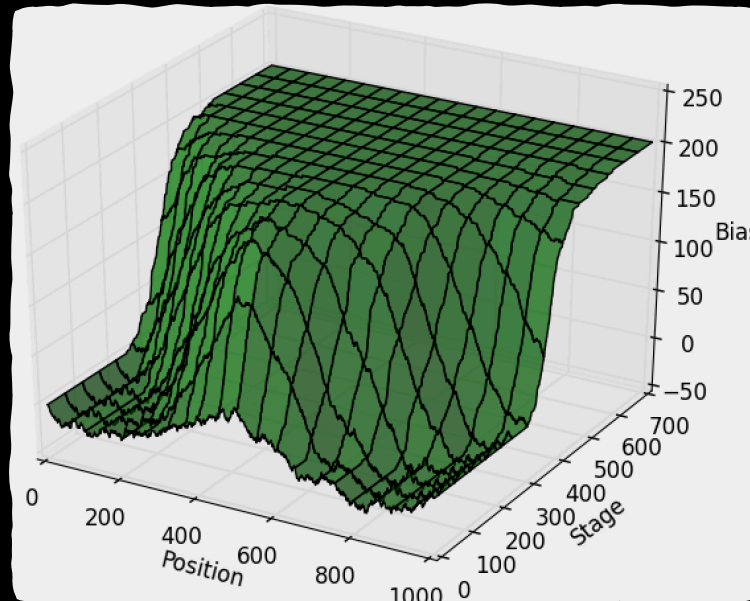
*A **cascade** of movement of agents during the process of segregation.*

The logic of the analysis of the minority case.

Continued study of the 2D and 3D models

Conclusion

Micromotives and Macrobehaviour paradox

In balanced populations and intolerance 35%-50%, increased tolerance to mix leads to larger segregation. This is a formal manifestation of the fact that *clear trends in personal preferences of the agents sometimes result in completely opposite global outcomes.*

Power of the minority

If the agents require more than 50% same-type neighbors, a tiny minority, anything larger than 0%, drives the whole population to full segregation.