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Räumliche Selbstorganisation in der Standortverteilung

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Gliederung

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1. Hierarchische und räumliche Verteilung von Standorten

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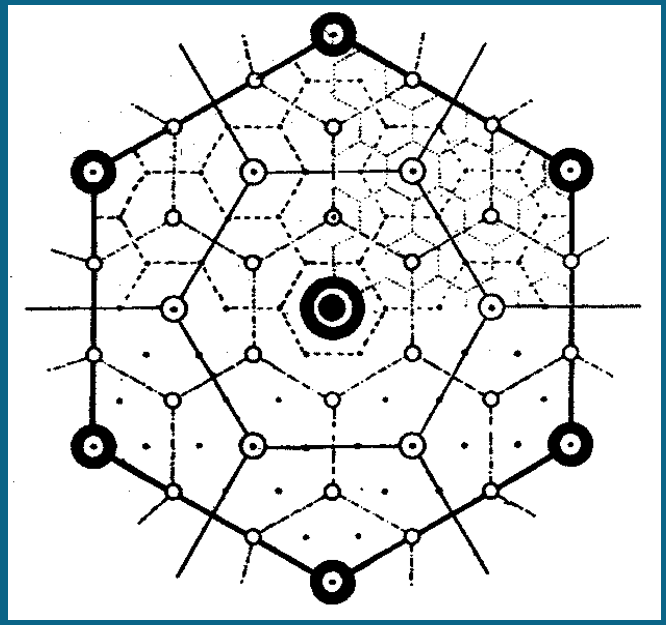
5. Schlußfolgerungen

Central Place Theory



Walter Christaller: *Die zentralen Orte in Süddeutschland.*
Eine ökonomisch-geographische Untersuchung über die Gesetzmäßigkeit der Verbreitung und Entwicklung der Siedlungen mit städtischen Funktionen, Jena: Fischer, 1933
(Reprint: Darmstadt: Wissenschaftliche Buchgesellschaft, 1980)

English translation by C.W. Baskin:
Central Places in Southern Germany, London: Prentice Hall, 1966

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Evolutionary perspective:

$\Rightarrow$ *Dynamical principles* which generate the hierarchical and spatial distribution *bottom up*

Hierarchical Rank-Size Distribution

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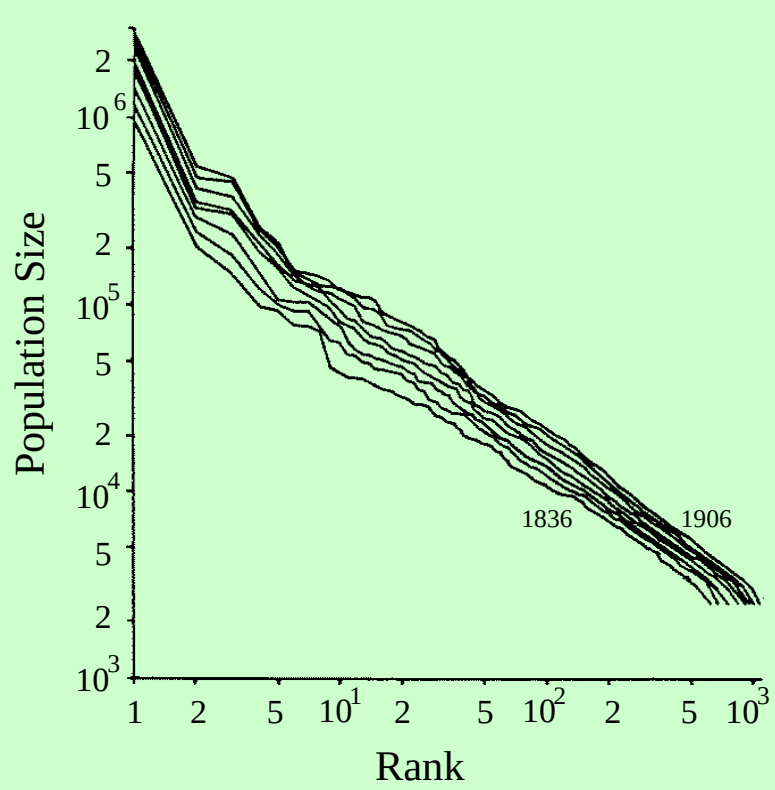

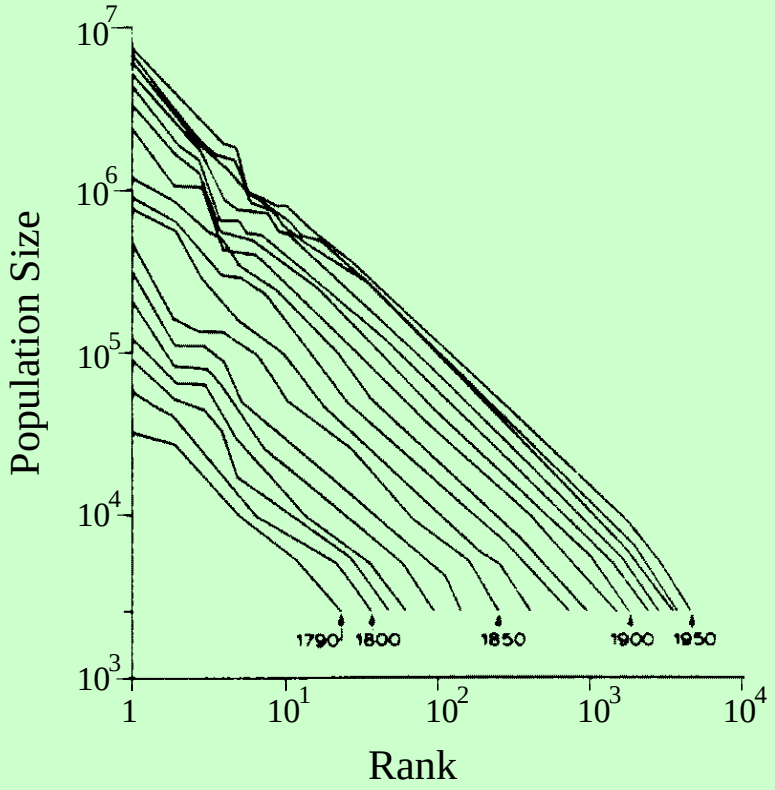

Population of cities in different countries in the course of time:

France (years 1836-1906) USA (years 1790-1950)

Pareto-Zipf Distribution:

$$n_k(t) = n_1(t)\, k^{-q(t)}$$

$n_k(t)$: population of the settlement with rank k
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- characteristic feature for *many* hierarchical organizations
- may result from various dynamical assumptions

Spatial Distribution of Locations

empirical evidence:

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empirical evidence:

- characteristic distance of locations with the same rank
- coexistence of multiple locations ?
- in a critical distance

buttom-up approach:
economic actors
self-organization

Complex System

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"By complex system, it is meant a system comprised of a (usually large) number of (usually strongly) interacting entities, processes, or agents, the understanding of which requires the development, or the use of, new scientific tools, nonlinear models, out-of equilibrium descriptions and computer simulations."

Journal "Advances in Complex Systems"

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  - global / indirect interactions (coupling via resources)

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- *Solution:*
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  personally addressed interaction instead of “broadcasting”
- *freedom:* define rules *and* interactions $\Rightarrow$ *pitfall*

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  - specific for each agent $\Rightarrow$ enables actions, decisions

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- "hiring" and "firing": $C_0 \underset{k^+}{\overset{k^-}{\rightleftharpoons}} C_1$
- migration: overdamped Langevin equation:

$$\frac{d\boldsymbol{r}_i}{dt} = \boldsymbol{f}(\boldsymbol{r}_i) + \sqrt{2D}\,\boldsymbol{\xi}_i(t)$$

$\boldsymbol{f}(\boldsymbol{r}_i)$: guiding force, *local* influence

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\end{aligned}$$

◇ *economic theory*: determine $\boldsymbol{f}(\boldsymbol{r},t)$, k^+, k^-

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prefactor A: represents level of productivity
$\beta < 1$: decreasing returns to scale

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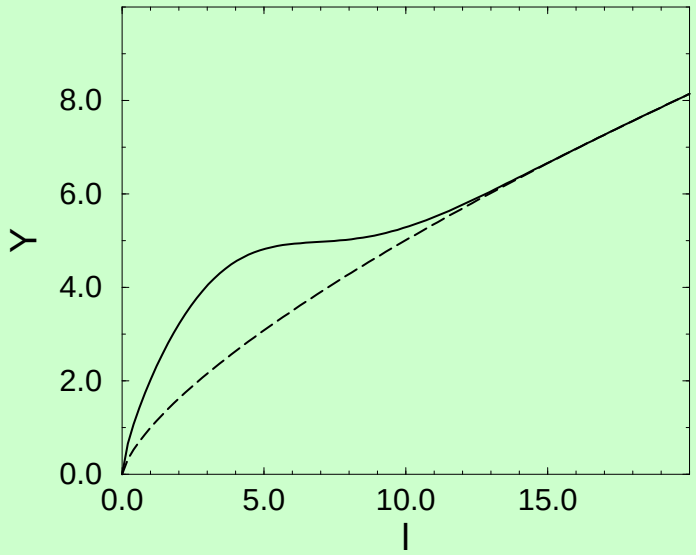

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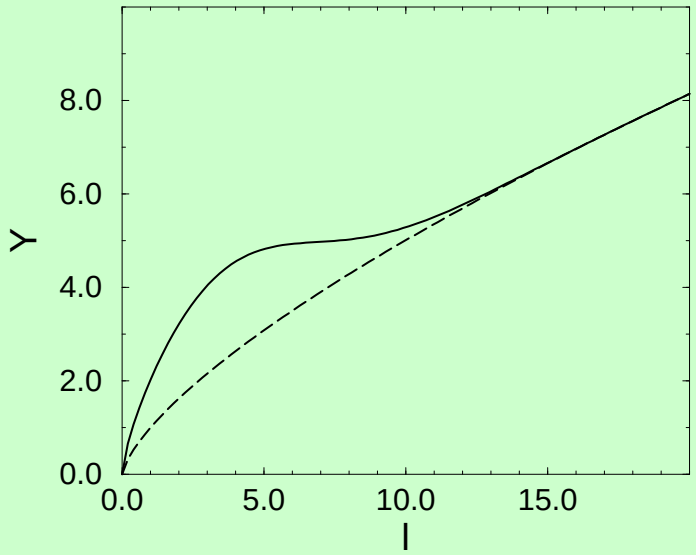

- $a_2 < 0$: saturation effects $\Rightarrow$ advantages of cooperative effects compensated by disadvantages of crowding

wage: marginal product of labor:

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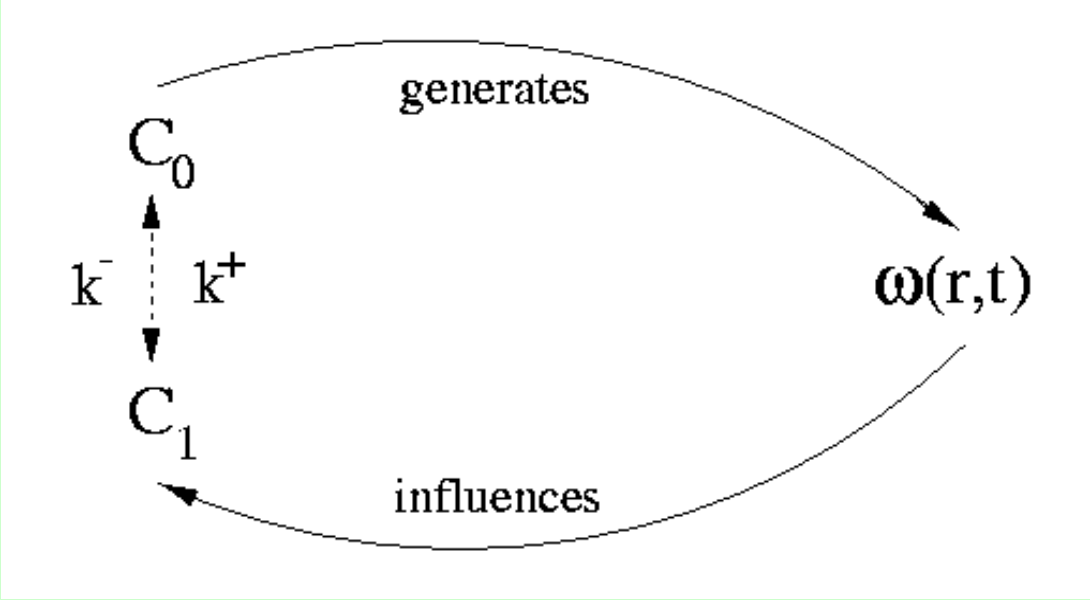

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firing rate k^-: external and internal reasons
(i) workers are fired if $\frac{\delta Y}{\delta l} < \omega^\star$
(ii) workers can quit their job for better opportunities

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Spatial density of employed agents

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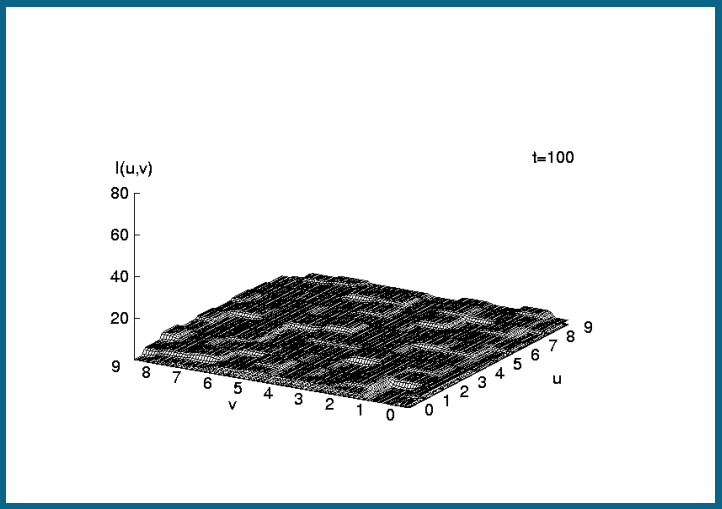

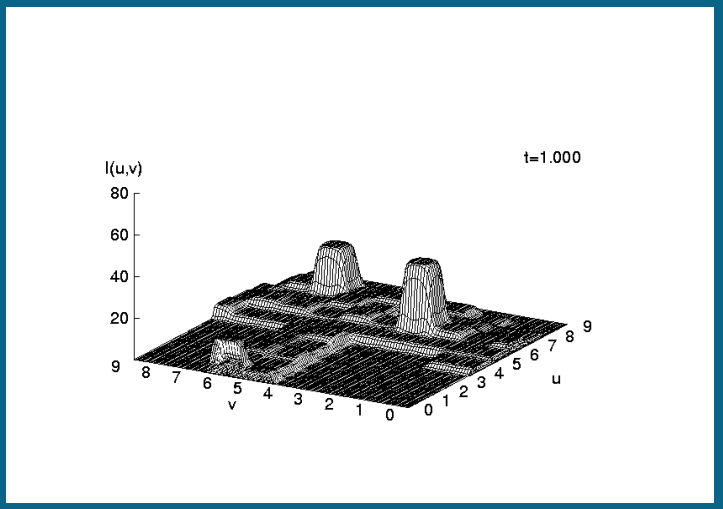

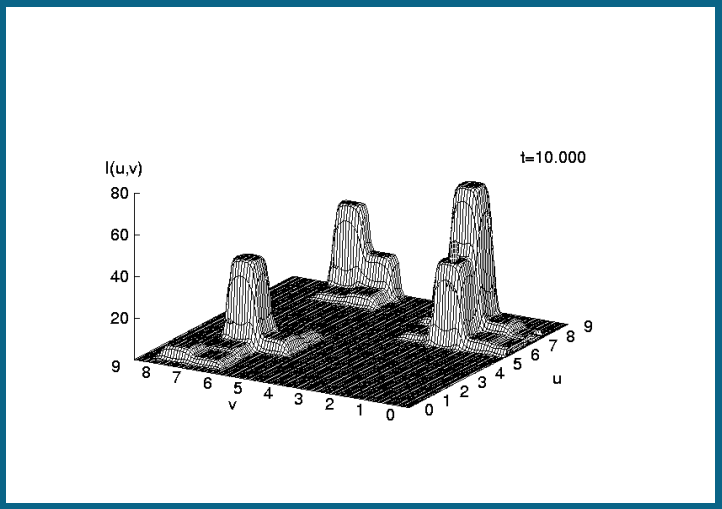

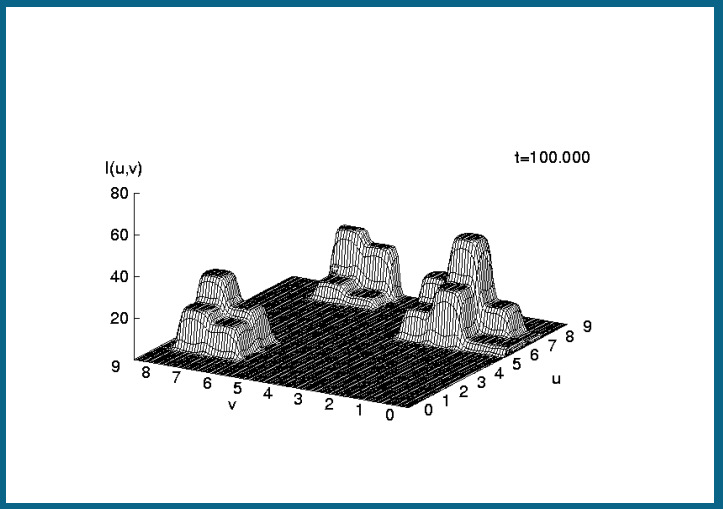

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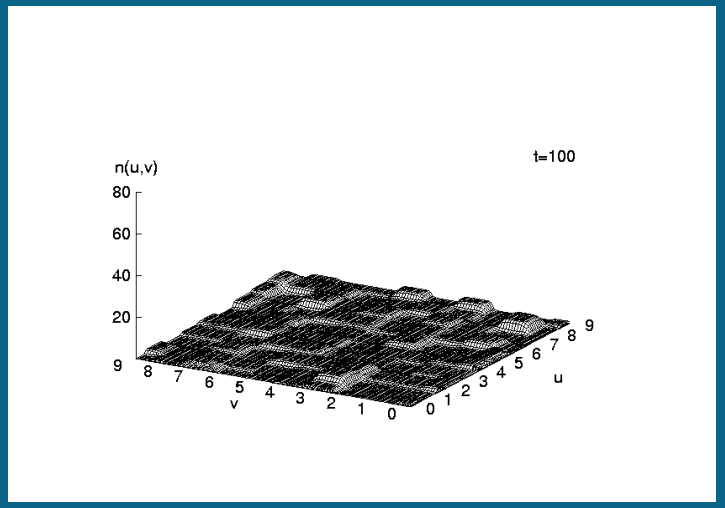
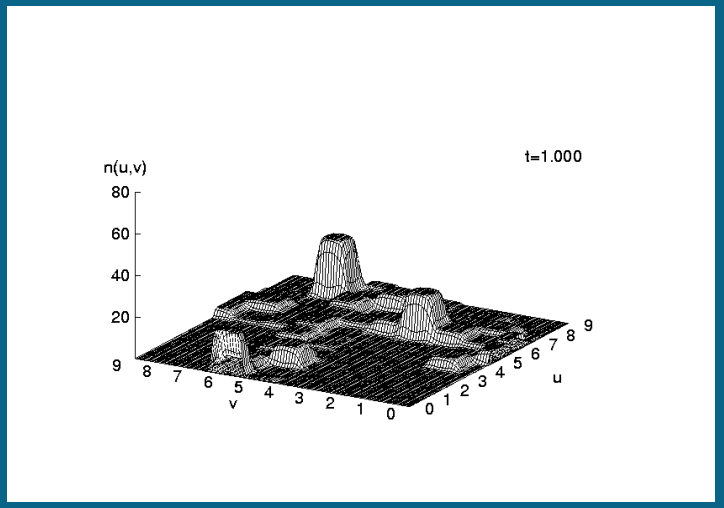
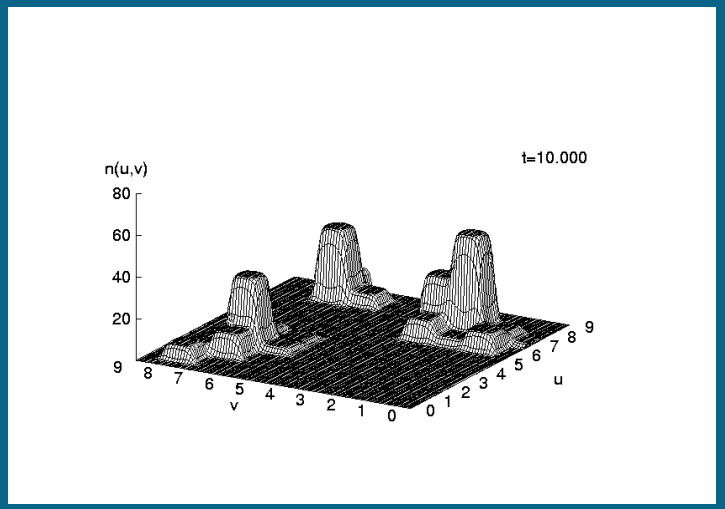
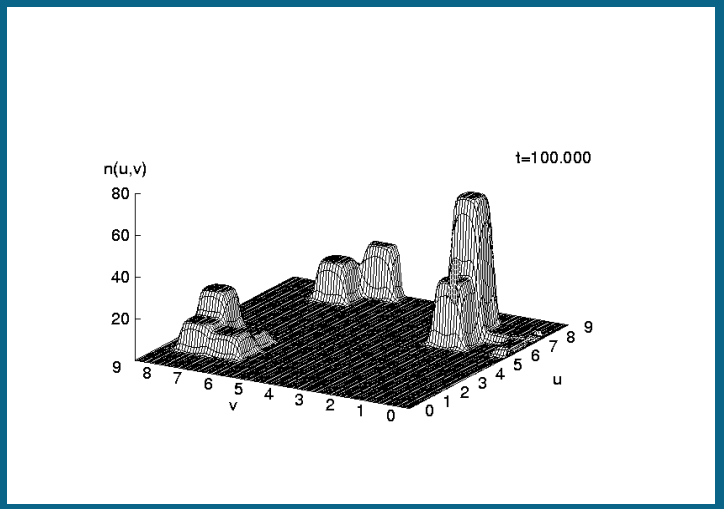
Spatial density of unemployed agents

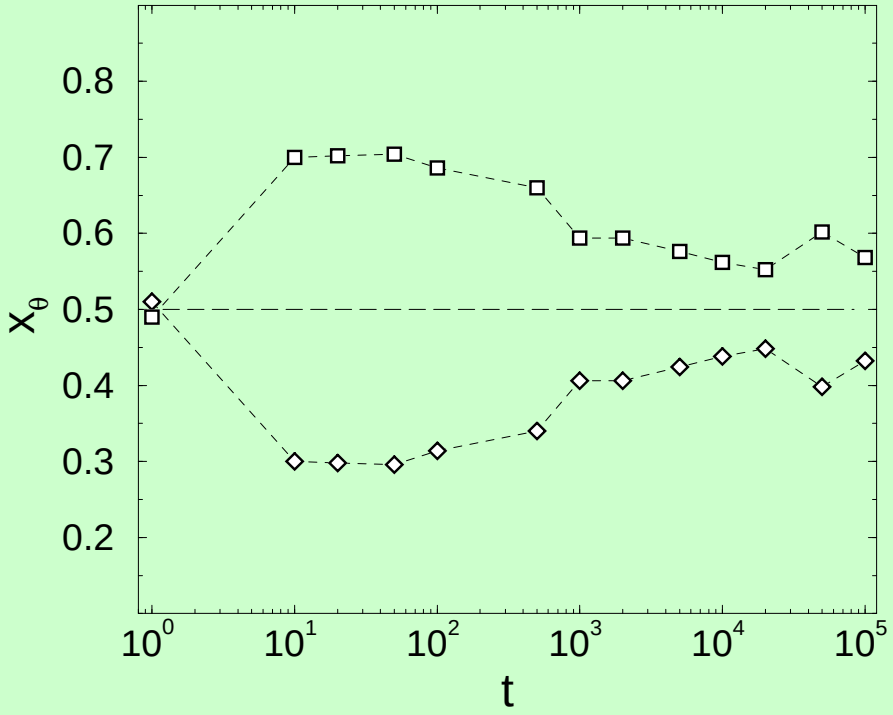






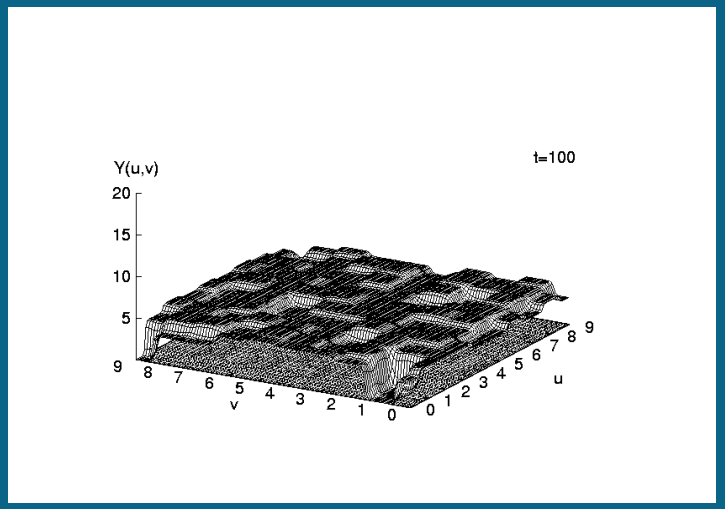


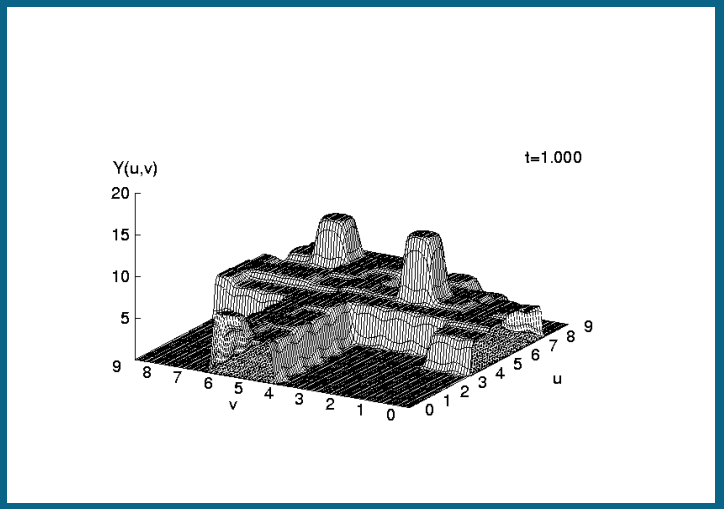
Total share $x_\theta \equiv N_\theta / N$

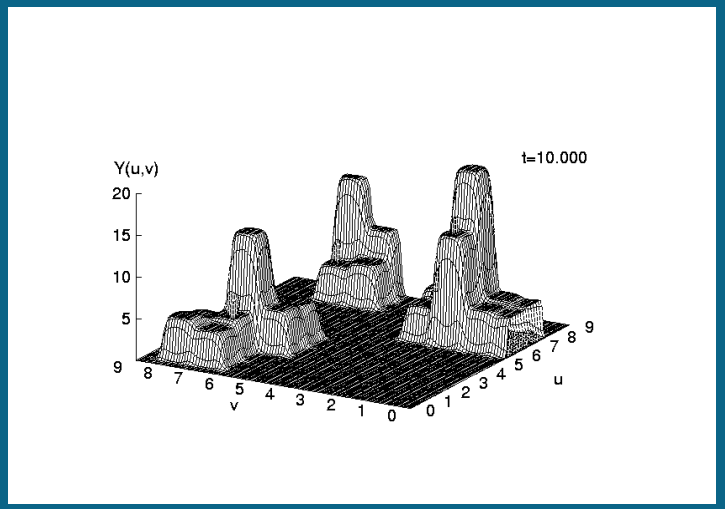


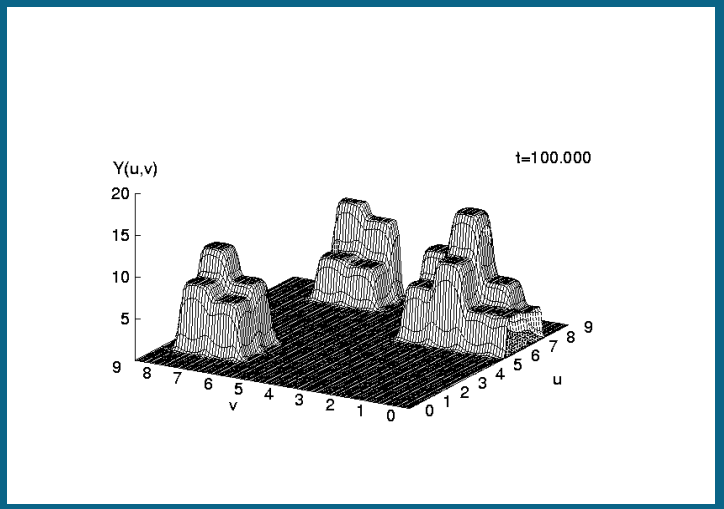
employed agents: (□) unemployed agents (◊)

Spatial distribution of production









Results of Computer Simulations

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$t = 0$: random initial distribution

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$t = 100.000$: distinct *extended major economic regions*

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  $\Rightarrow$ stable centers, but *increase of unemployment*

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⇒ coexistence of small (innovative) firms and large scale production

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- internal degrees of freedom $\Rightarrow$ variety of responses
- parallel *independent* actions *coupled* by information flow

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solutions result from the non-linear interaction
boundary conditions (semi-structured environment)

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  top-down approach: design a solution $\Rightarrow$ planning

Self-Organization

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Self-organization is the process by which individual subunits achieve, through their cooperative interactions, states characterized by new, emergent properties transcending the properties of their constitutive parts.

Biebricher, C. K.; Nicolis, G.; Schuster, P.: Self-Organization in the Physico-Chemical and Life Sciences, EU Report 16546 (1995)

Self-organization is defined as spontaneous formation, evolution and differentiation of complex order structures forming in non-linear dynamic systems by way of feedback mechanisms involving the elements of the systems, when these systems have passed a critical distance from the statical equilibrium as a result of the influx of unspecific energy, matter or information.

SFB 230 “Natural Constructions”, Stuttgart, 1984 - 1995