

Introduction to Computational Modeling of Social Systems

Emergent Structure Models

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<http://www.icr.ethz.ch/teaching/compmodels>

Lecture, February 1, 2005

Today's agenda

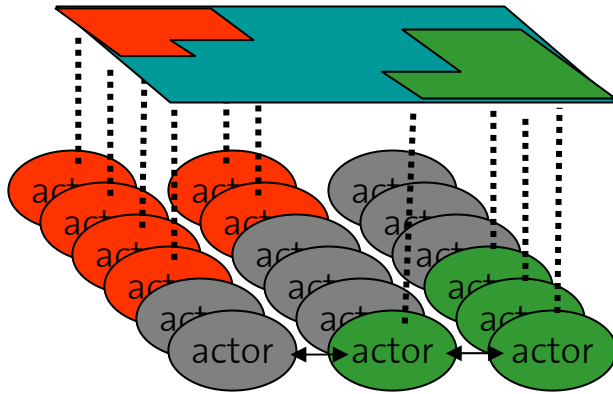
- Four types of generative models
- Emergent-structure models
 - Schelling's segregation model
 - Measuring property configurations
 - Axelrod's culture model

Emergent social forms

1. Interaction patterns
2. **Property configurations**
3. Dynamic networks
4. Actor structures

2. Emergent property configurations

- Models of “emergent structure” constituted as property configurations
- Example: Schelling’s segregation model; Axelrod 1997



A view from the Berlin television tower



Ethnic neighborhoods

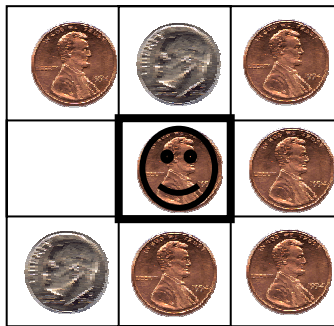


Little Italy, New York City

Chinatown, New York City

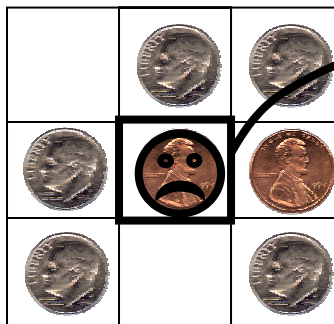
Neighborhood segregation

Micro-level rules of the game

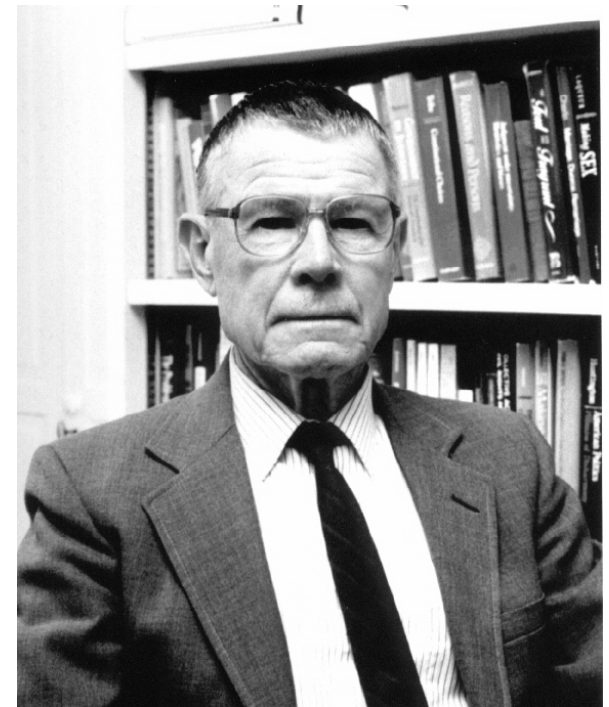


Stay if at least a third of neighbors are "kin"

$< 1/3$



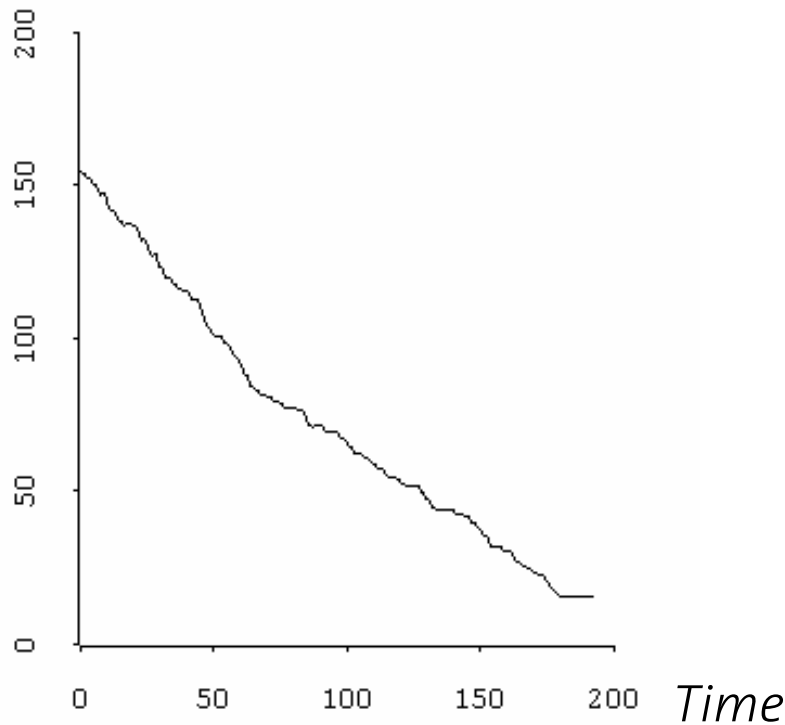
Move to random location otherwise



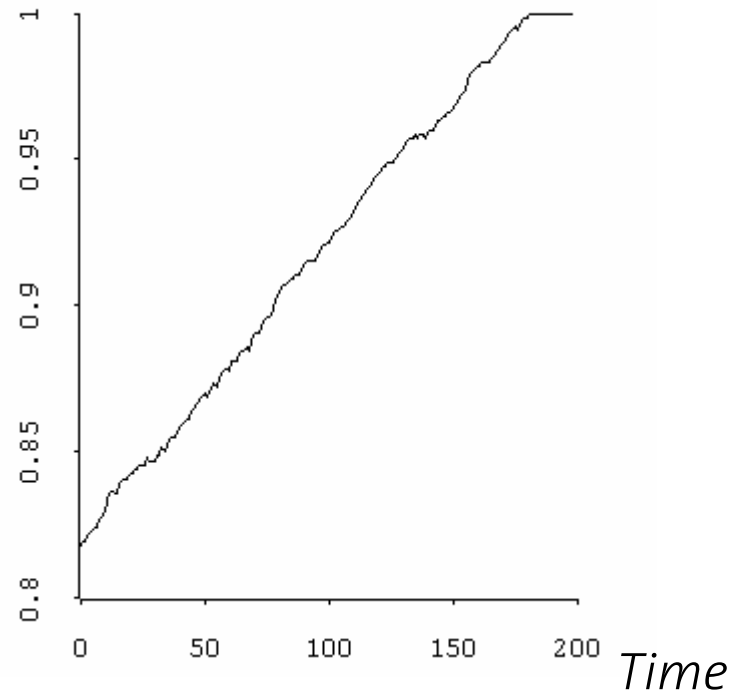
Thomas C. Schelling
*Micromotives and
Macrobavior*

Emergent results from Schelling's segregation model

Number of neighborhoods

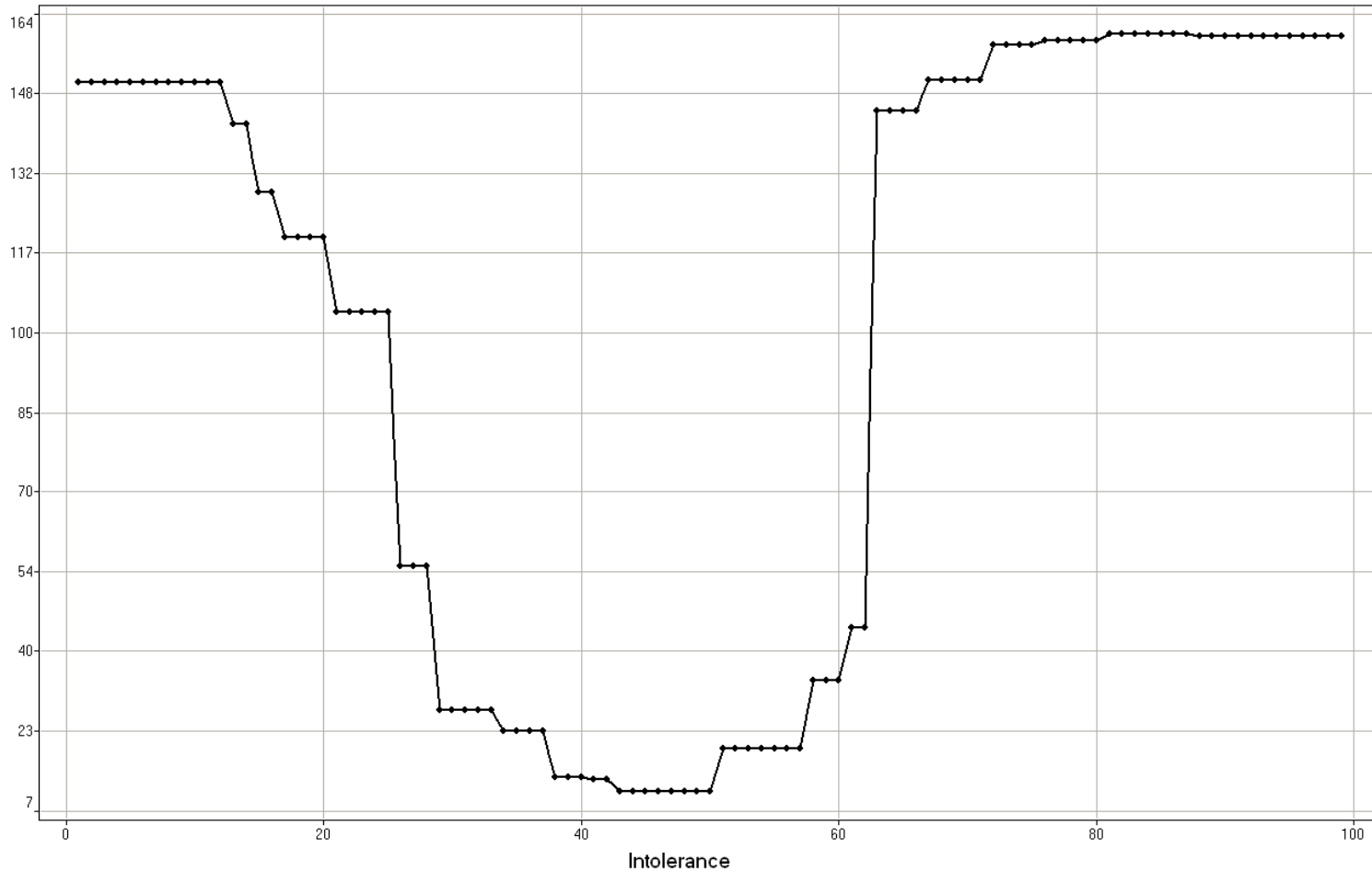


Happiness



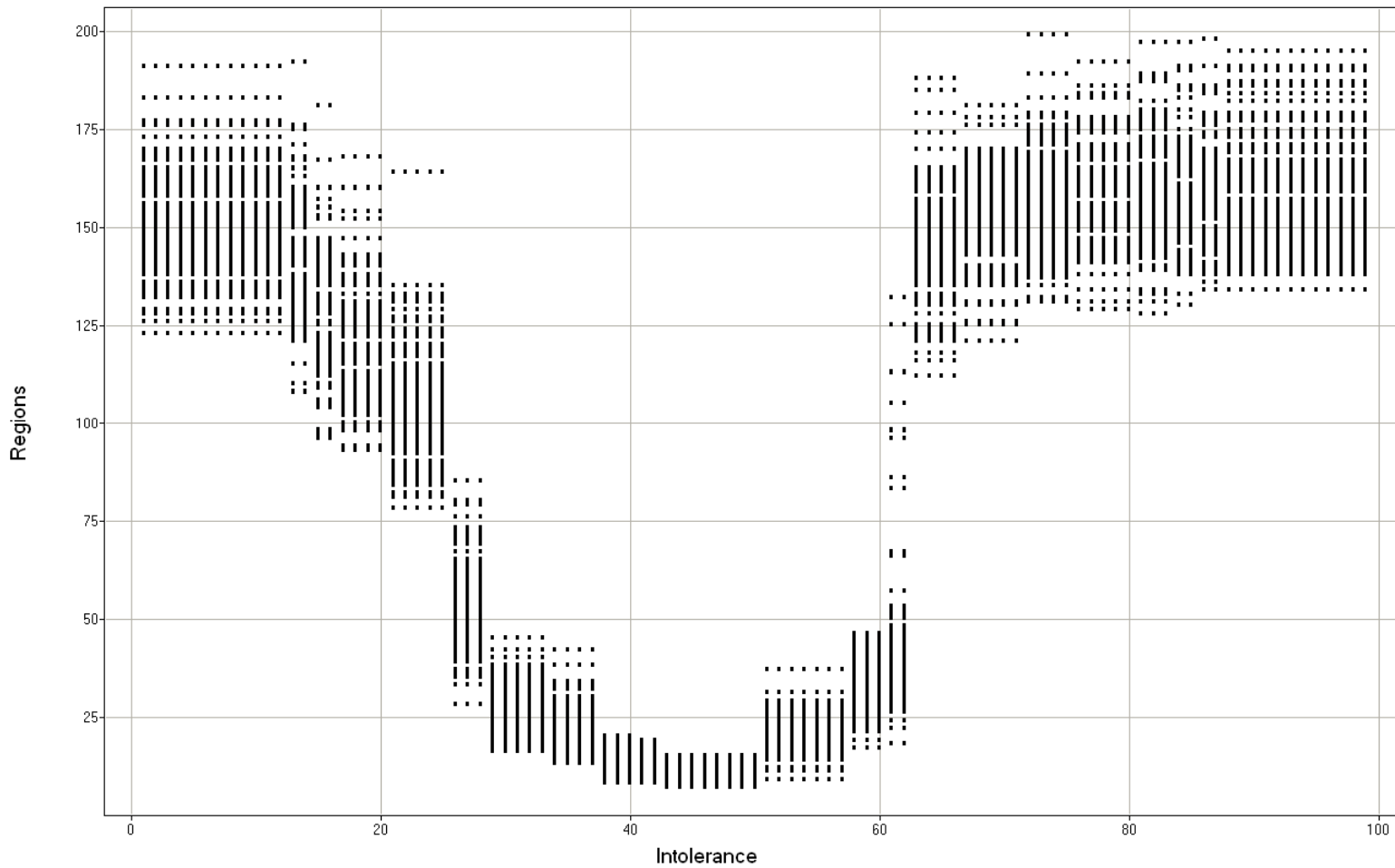
Analyzing segregation

Average number of regions



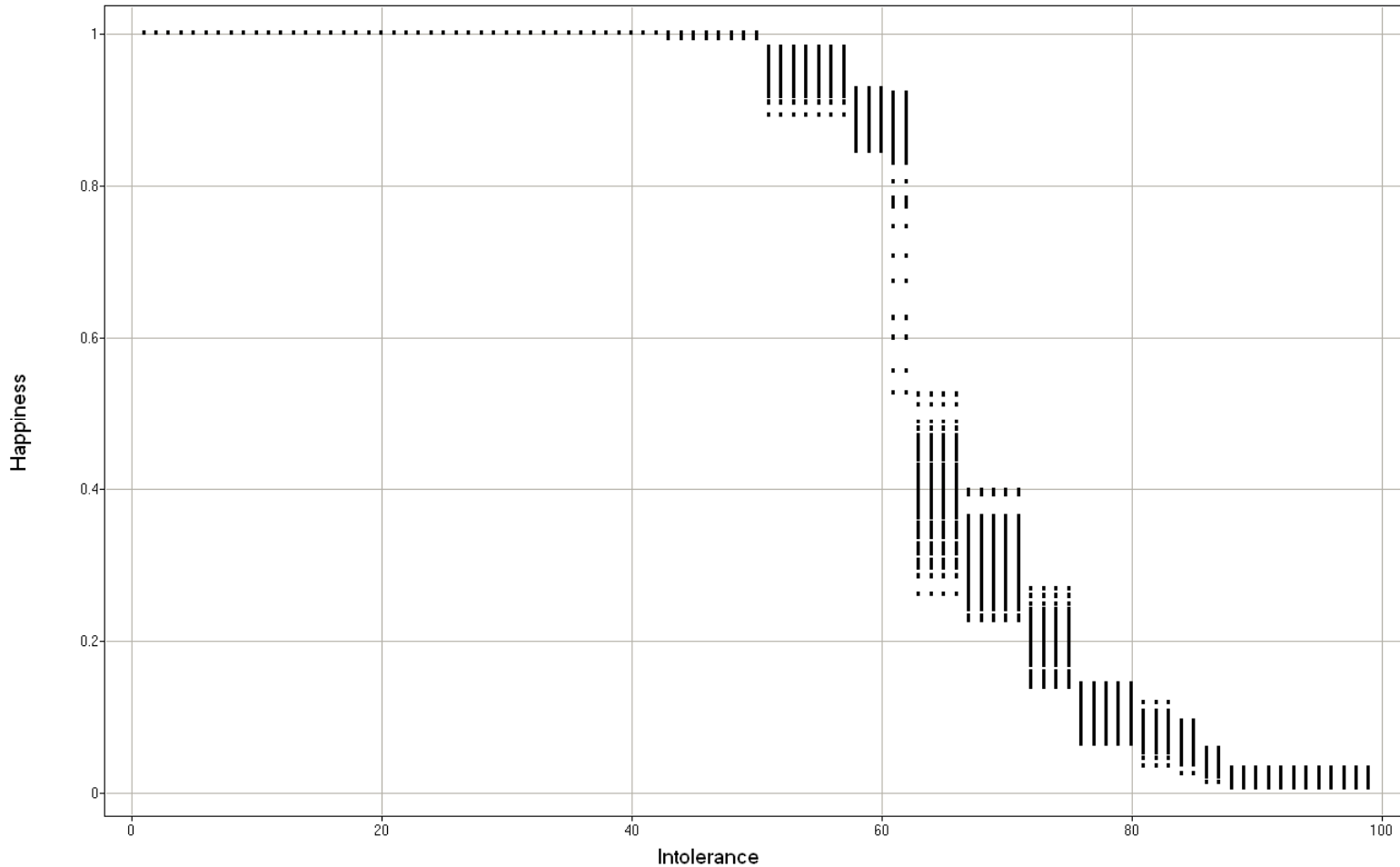
Analyzing segregation

Distribution of number of regions



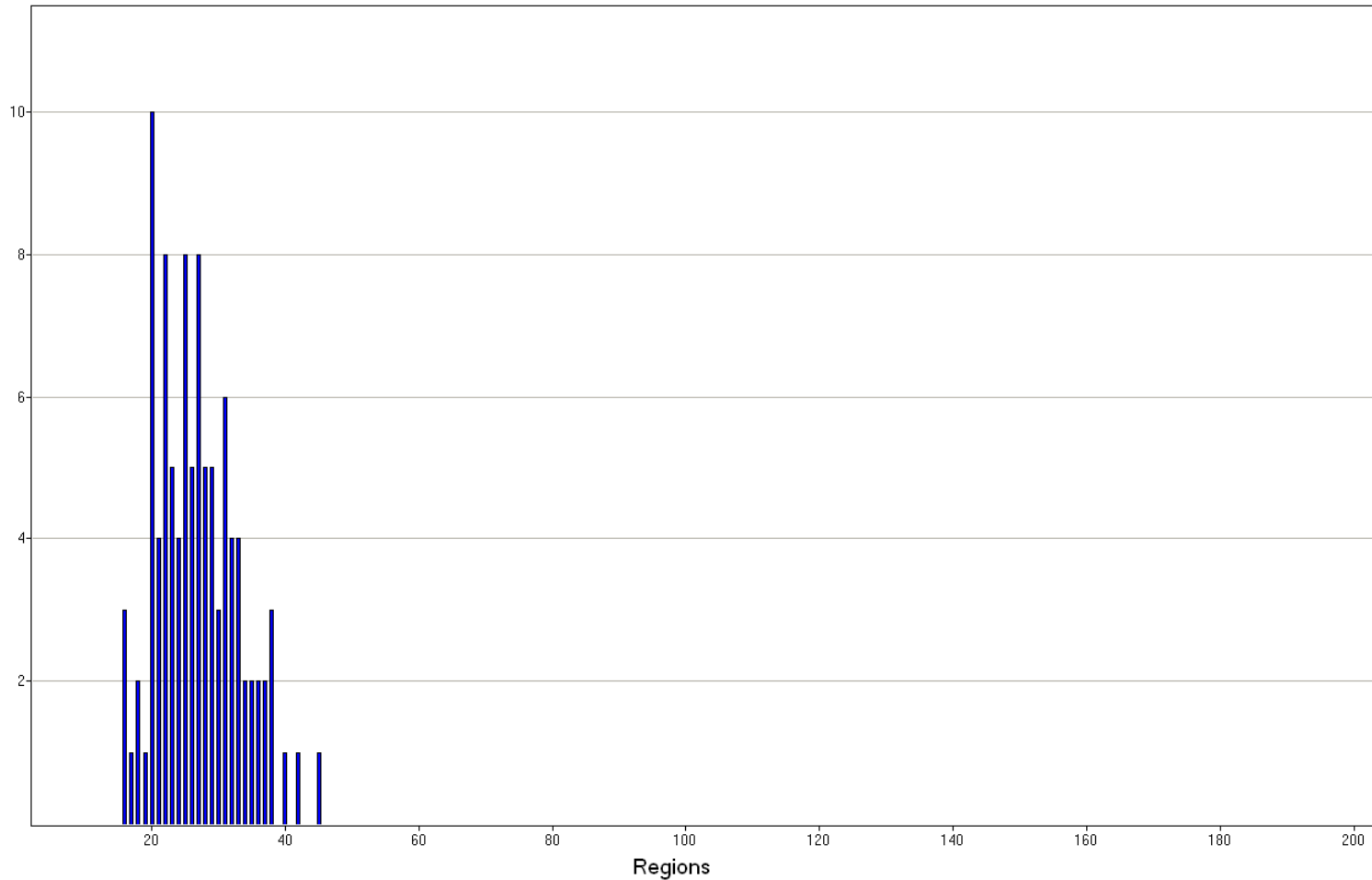
Analyzing segregation

Happiness distribution



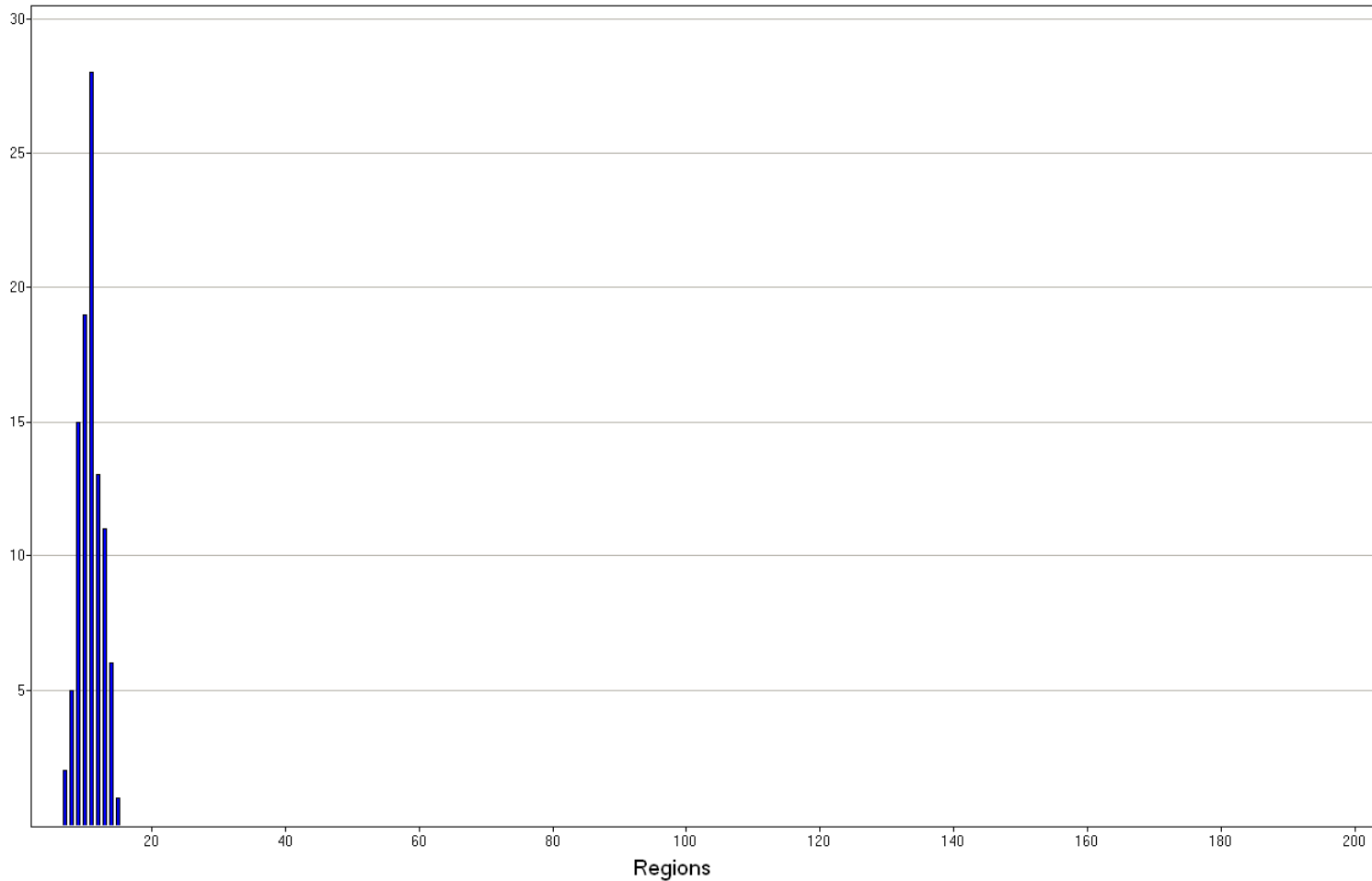
Analyzing segregation

Number of regions for intolerance level 33



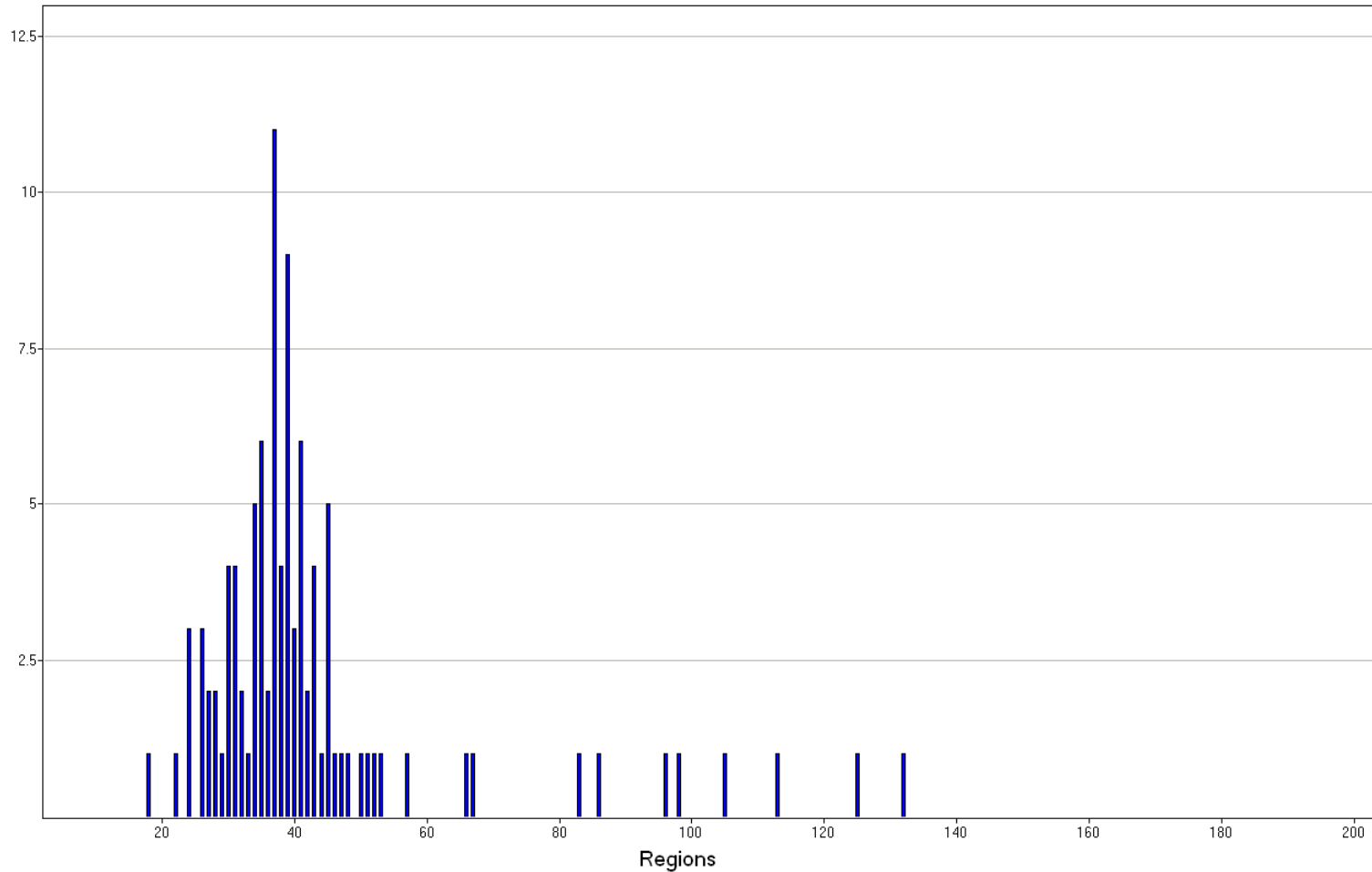
Analyzing segregation

Number of regions for intolerance level 50



Analyzing segregation

Number of regions for intolerance level 61



Recursion

- Functions that call themselves:

$$f(n) = \begin{cases} n f(n-1) & \text{if } n > 1 \\ 1 & \text{if } n = 1 \end{cases}$$

Ex: $f(7) = 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$

- Can be replaced by loops
- Often elegant but can be slow and interminable

Counting neighborhoods

1	1	2	2	2	0	0				
1	0	0	0	2	0	0				
1	1	1	2	2	2	0				
1	1	0	0	2	0	0				
				0						

*Depth-first
recursion!*

Extensions

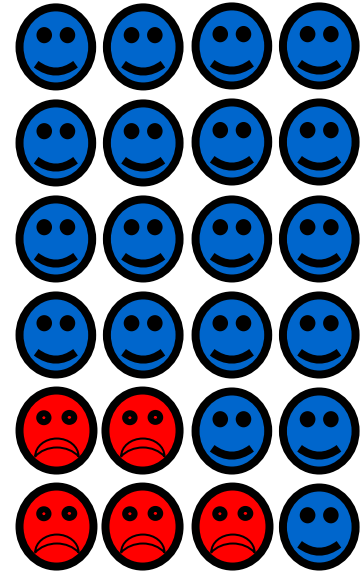
- Empirical validation
 - Bruch & Mare. 2004. “Neighborhood Choice and Neighborhood Change.” CPR-007-04.
- Theoretical extensions
 - Kollman, Miller & Page. 1997. “Political Institutions and Sorting in a Tiebout Model.” *American Economic Review* 87: 977-992.

Social impact theory

- “Light-bulb” theory of social influence:
 $\hat{i} = f(SIN)$ where
 S is strength
 I is immediacy
 N is the number of sources
- Nowak, Szamrej & Latané 1990. “From Private Attitude to Public Opinion.” *Psychological Review* 97: 362-376
- Based on social-psychological experiments and theories

Results of social impact theory

- Four main patterns:
 - Consolidation
 - Clustering
 - Correlation
 - Continuing diversity
- Cf. spin glasses!



Axelrod 1997

- Why are differences durable?
 - Social differentiation
 - Fads and fashions
 - Preference for extreme views
 - Drift
 - Geographic isolation
 - Specialization
 - Changing environment
 - **Homophily**

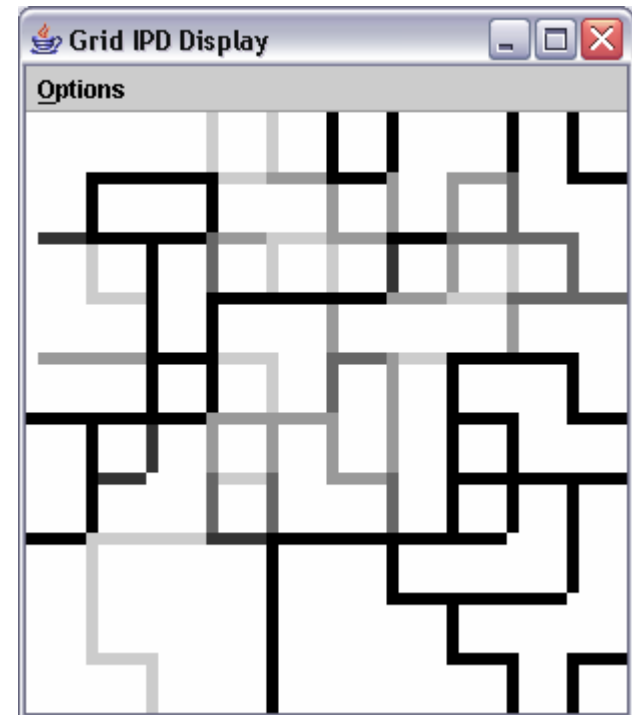
Axelrod's Culture Model

- Multi-dimensional model of cultural evolution (features and traits)
 - Representing culture as a vector of symbols:

```
47915 07982 77785 21612 47150 89321 63528 47793 03741 82574
10748 88936 01313 59316 47445 90082 27753 42657 01255 93320
70954 22446 31201 01180 20638 28356 42940 88786 86066 98070
06865 00013 97137 67556 37096 77500 17083 74593 60482 00049
89650 09313 67959 30446 01151 84366 10378 53515 16401 63722
54764 86218 00954 22845 62902 49985 77417 43254 33649 10579
10956 52610 68968 91660 09199 99174 89339 30968 21230 29734
07114 30073 40666 29350 80645 11890 65514 48965 45395 14394
69761 53743 77800 02737 71448 93604 40796 72326 88180 08077
58839 87747 62945 19469 40766 83282 68810 78511 73375 50563
```

Simulation loop

1. Pick a random site i as the active one and a neighbor j
2. With a probability proportional to the similarity between i and j , they interact
 - similarity is measured as the proportion of features that are the same for i and j
 - interaction means selecting a random feature on which i and j differ and setting that feature to the trait of i



Replication results

- More features ==> Fewer regions
- More traits ==> More regions
- Larger neighborhoods ==> Fewer regions
- Larger grids ==>

