

Understanding and Solving Societal Problems with Modeling and Simulation

Lecture 2: Residential Segregation

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Aims of this lecture

- Understand the micro-macro problem
- Understand Schelling's model of residential segregation
- Introduction to NetLogo

The Micro-Macro-Problem



Sociology is concerned with macro phenomena

- Macro phenomena describe collectives such as groups, organizations and societies. They are distinguished from individual (micro) phenomena, which are studied by psychologists.
- Examples: gross domestic product, birth rate, income inequality, social movements, opinion polarization, voter turnout

Structural approach to Sociology:

The “whole does not equal the sum of its parts; it is something different, whose properties differ from those displayed by the parts from which it is formed.” (Durkheim 1982:128)

Durkheim concluded:

“The determining cause of a social fact must be sought among antecedent social facts and not among the states of the individual consciousness.” (Durkheim 1982:134)

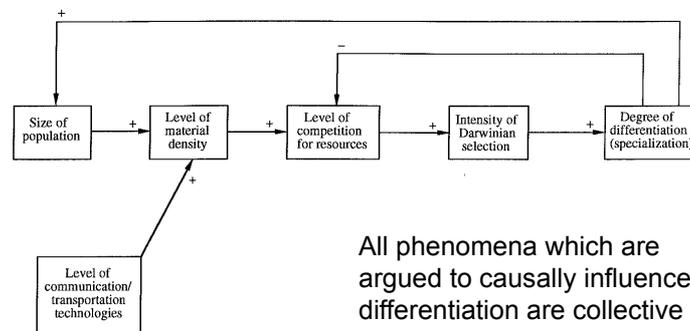


Émile Durkheim
(1858 - 1917)



The structural approach to sociology

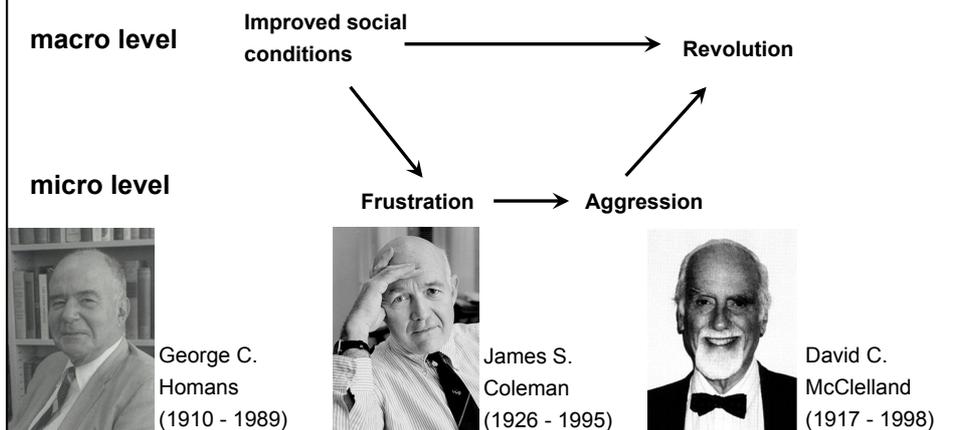
- Collective phenomena can and should only be explained with other collective phenomena.
- This is a typical example from Durkheim's work (explicated by Turner 1995: 20): Durkheim's theory of differentiation



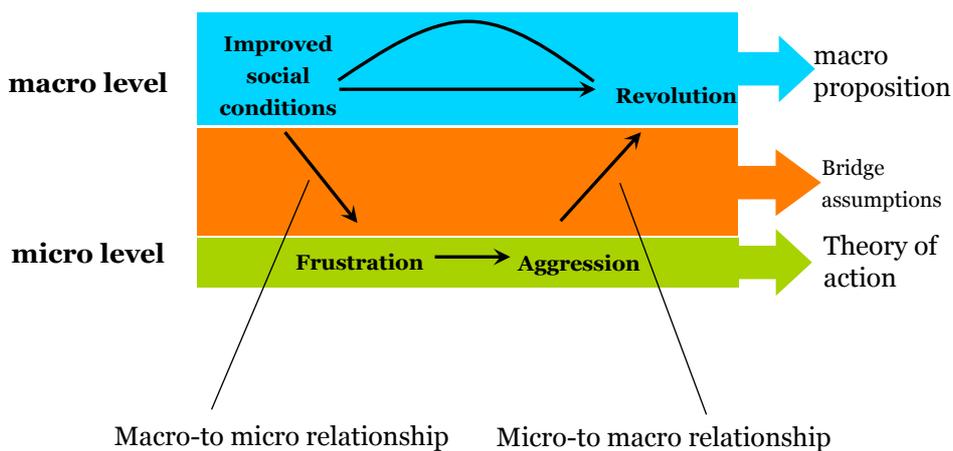
All phenomena which are argued to causally influence differentiation are collective phenomena

The structural-individualistic research program

- SIP holds that collective phenomena can and should be explained by drawing on the micro-level
- Mainly based on work by George Homans
- Basic model: **The Coleman boat** (see also McClelland 1961)



Typical example (Coleman 1990):



- A more elaborate micro-model model of protest (Opp and Gern 1993):

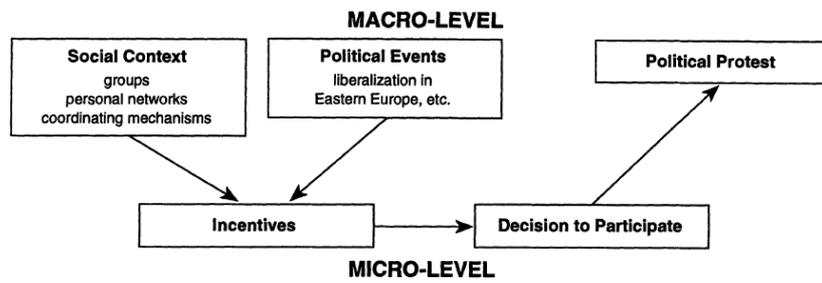
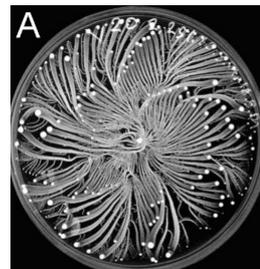


Figure 1. Theoretical Model for Explaining the Emergence of Large-Scale Political Protests

The micro-macro problem in other fields



Bacteria (Ingham et al 2008)



Termite mounds

A classical Micro-Macro Phenomenon: Residential Segregation



Residential Segregation in the US

Racial-Ethnic Concentration
NYC Tracts with Pop of 100 or More

- Single Race ID's
- N.H. Whites 75% +
 - N.H. Whites 50-75%
 - N.H. Blacks 75% +
 - N.H. Blacks 50-75%
 - Hispanics 75% +
 - Hispanics 50-75%
 - N.H. Asians 75% +
 - N.H. Asians 50-75%
 - No One Ethnic Majority

2000

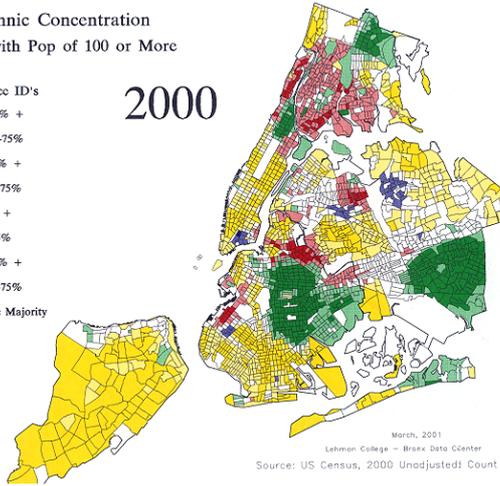
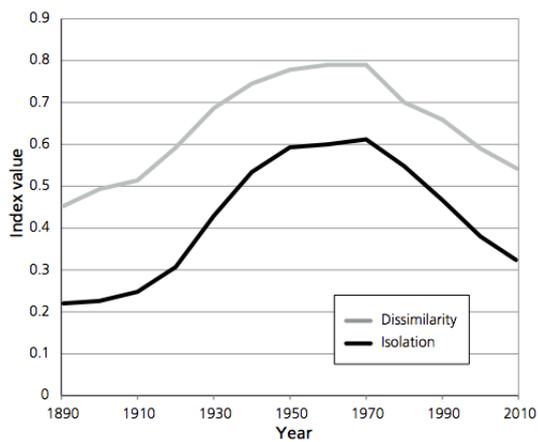


Figure I. Black/Nonblack Segregation 1890–2010



Source: Glaeser and Vigdor, 2012

Average segregation, as experienced by the average urban black US resident

Dissimilarity: proportion of individuals that would have to move in order to achieve perfect integration

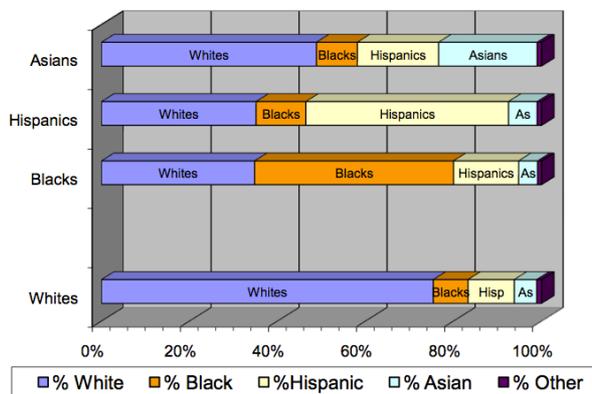
Isolation: tendency of persons to live in a neighborhood where their share is above the city average

Why has segregation declined? (Glaeser and Vigdor 2012)

- Change in law, which banned race-based zoning
- Easing of credit standards (black people can afford expensive houses)
- Interregional migration (black people leave segregated cities)
- Massive housing projects built at peak of segregation were demolished
- Inflow of foreign-born residents

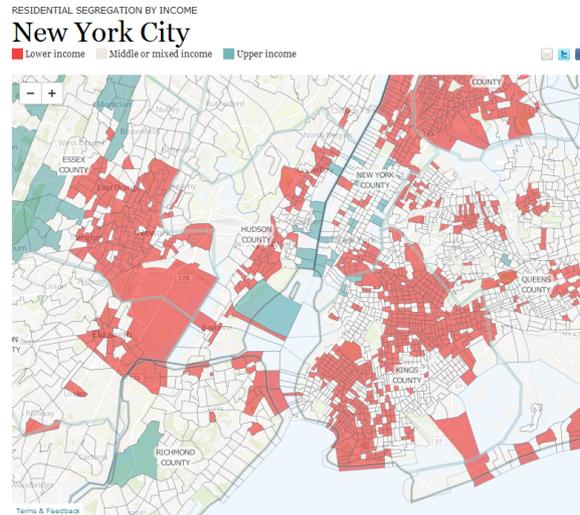
Black-White segregation has decreased, but other groups have grown

Figure 1. Diversity Experienced in Each Group's Typical Neighborhood - National Metropolitan Average, 2010 Census



Source: American Communities Project, Brown University

Residential Segregation of Income



Residential Income Segregation Index (RISI) in the 10 Largest Metros, 1980 and 2010

	1980	2010	Change 1980 to 2010
Houston	32	61	29
Dallas	39	60	21
New York	49	57	9
Los Angeles	47	51	4
Philadelphia	39	51	11
Miami	30	49	20
Washington	43	47	4
Atlanta	42	41	0
Chicago	35	41	6
Boston	31	36	5

Notes: The RISI score for a metro area is derived by adding the share of its lower-income households located in majority lower-income census tracts to the share of its upper-income households located in majority upper-income census tracts. "Change 1980 to 2010" calculated prior to rounding.

Source: Pew Research Center tabulations of 2006-2010 American Community Survey (ACS) 5-year file and Geolytics 1980 Census data in 2000 boundaries.

Distribution of Households by Income Group

% of households that are ...



Notes: Based on households in the nation's 942 metropolitan and micropolitan statistical areas.

Source: Pew Research Center tabulations of 2006-2010 American Community Survey (ACS) 5-year file, 2000 Decennial Census SF3 data, Geolytics 1990 long-form data in 2000 boundaries, and Geolytics 1980 Census data in 2000 boundaries.

Neue Zürcher Zeitung

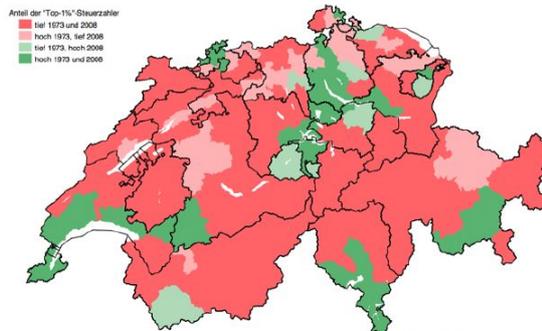
9. Mai 2012, 12:04

Wenn Ghettos plötzlich am Zürich- und Genfersee liegen

Spitzenverdiener in der Schweiz wohnen in relativ wenigen Regionen

Übersicht 9. Mai 2012, 12:04

Wo wohnt das oberste Prozent der Steuerzahler in der Schweiz?



Quelle: ESTAT, Statistik der natürlichen Personen: "Top-1%" Steuerzahler mit steuerbarem Einkommen (in absoluten Personen) 1973/2008, %aF (hoch) - (-) Durchschnitt der Bezirke

Which social mechanisms explain residential segregation?



Schelling's model of residential segregation

- Schelling's question: Which social mechanisms explain residential segregation?

Discuss with your neighbor

If you were to develop a model of residential segregation, which assumptions about the behavior of the individuals would you include?

You have 3 minutes.

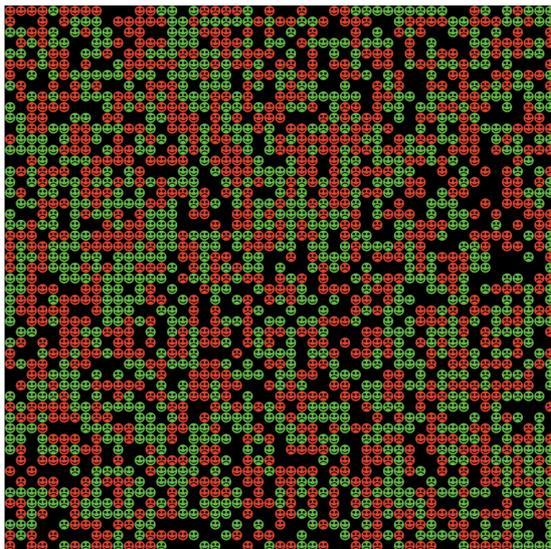


Thomas C. Schelling



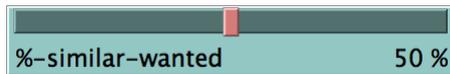
- NetLogo is a free Agent-based modeling toolbox
- <http://ccl.northwestern.edu/netlogo/>
- Main advantages:
 - Great graphical output
 - Very simple programming language
 - Link to R and Mathematica
 - Rich model library (including the Schelling model!) and huge active community
- Main disadvantages:
 - slow
 - Language can be cryptic

- This is the city of *Schellingdale*:



- 2,500 homes arranged on a grid
- Each home has 8 adjacent homes
- 2,000 inhabitants
- Half of the inhabitants are *red*, the rest is *green*

- Variables are defined on the interface (e.g. with a slider) or in the code
- There are scalars and turtles-own variables (vectors with a cell for each turtle)
- There are global (always available) and local variables (only available in a given procedure)



```
globals [
  percent-similar
  percent-unhappy
]

turtles-own [
  happy?

  similar-nearby
  other-nearby
  total-nearby
]
```

- This NetLogo code creates Schellingdale (executed when the setup button is clicked):

```
to setup
  __clear-all-and-reset-ticks
  if number > count patches
    [ user-message (word "This pond only has room for " count patches " turtles.")
      stop ]

  ;; create turtles on random patches.
  ask n-of number patches
    [ sprout 1
      [ set color red
        set shape "face happy" ] ]
  ;; turn half the turtles green
  ask n-of (number / 2) turtles
    [ set color green ]
  update-variables
  do-plots
end
```

- Homes are represented as "patches"
- Inhabitants are represented as "turtles"

```
to update-variables
  update-turtles
  update-globals
end
```

- This tests whether an agent want to move:

```

to update-turtles
  ask turtles [
    ;; in next two lines, we use "neighbors" to test the eight patches
    ;; surrounding the current patch
    set similar-nearby count (turtles-on neighbors)
      with [color = [color] of myself]
    set other-nearby count (turtles-on neighbors)
      with [color != [color] of myself]
    set total-nearby similar-nearby + other-nearby
    set happy? similar-nearby >= ( %-similar-wanted * total-nearby / 100 )
    ifelse happy? [set shape "face happy"] [set shape "face sad"]
  ]
end

```

Boolean variable (true or false) that measures whether agents are happy with their current neighborhood's composition

Main parameter of the model: minimal proportion of similar neighbors needed to make agent refrain from moving

- This is the main engine of the model (executed when the go button is clicked):
- The go procedure is iterated until the **stop** command is executed

```

to go
  if all? turtles [happy?] [ stop ]
  move-unhappy-turtles
  update-variables
  tick
  do-plots
end

to move-unhappy-turtles
  ask turtles with [ not happy? ]
  [ find-new-spot ]
end

to find-new-spot
  rt random-float 360
  fd random-float 10
  if any? other turtles-here
    [ find-new-spot ]
  ;; keep going until we find an unoccupied patch
  move-to patch-here ;; move to center of patch
end

```

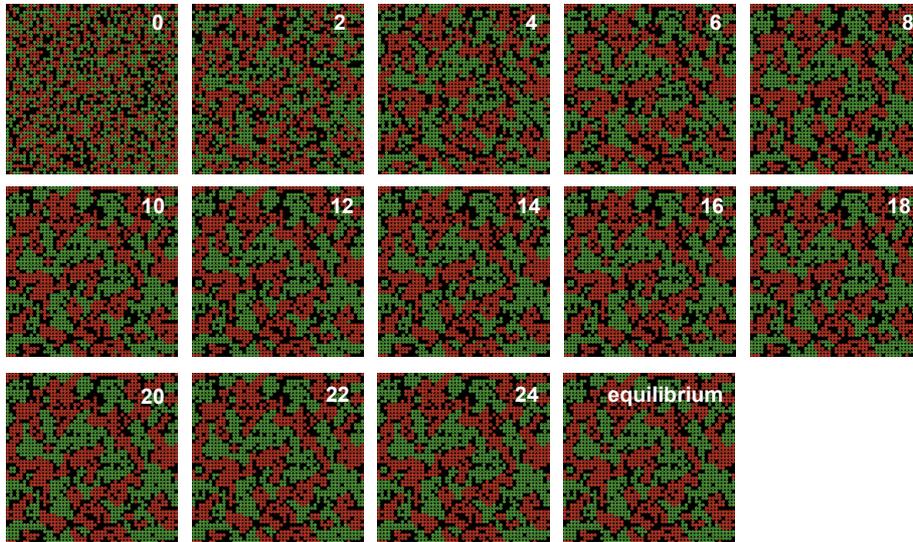
Stops dynamics if equilibrium is reached

Increases number of simulation events

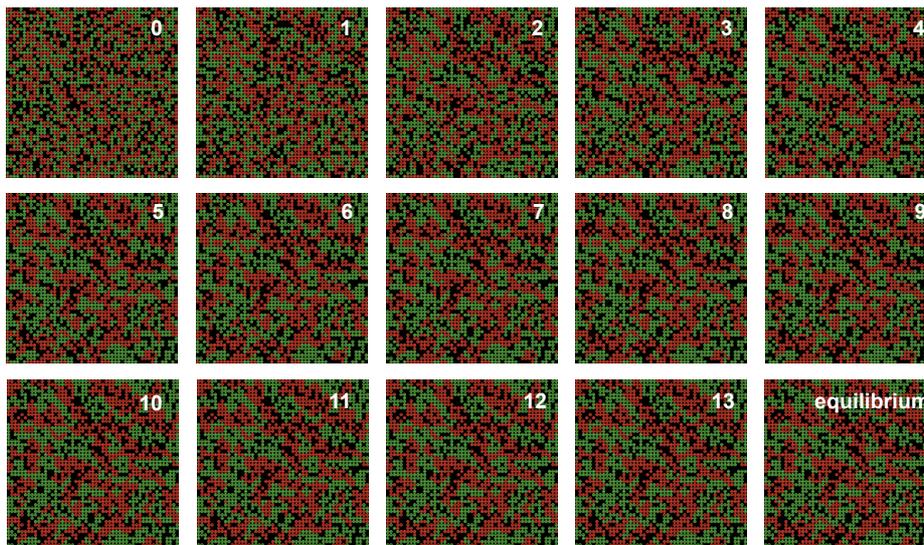
Selected agent are updated in a random order (sequentially)

Agent moves up to 10 steps in a random direction

A typical dynamic (%-similar-wanted = 50)



A typical dynamic (%-similar-wanted = 30)



Main finding

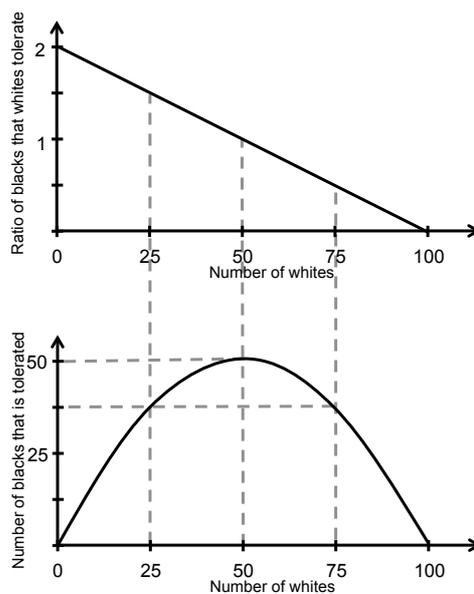
- Segregation emerges even under conditions where integration appears to be most plausible
 - Initial composition is random
 - Agents tolerate 69% dissimilar neighbors
 - Agents do not seek to live in segregated neighborhoods
 - Further mechanisms are excluded (e.g. income and housing prices)
- Residential segregation is an *emergent phenomenon* (remember Durkheim: the whole is more than the sum of its parts)
- Only based on the motives of the agents, one would not expect that segregation is the outcome.

Main dynamic

- If an agent moves, he can affect the decision of his former and new neighbors.
- E.g. a white agent who moves away ...
 - ... decreases the number of whites in his old neighborhood. Further whites might move out and blacks might move in (stay when they moved in)
 - ... increases the number of whites in the new neighborhood. Further whites might move here. Blacks might move out.
- Segregation is the result of a self-reinforcing feed-back loop

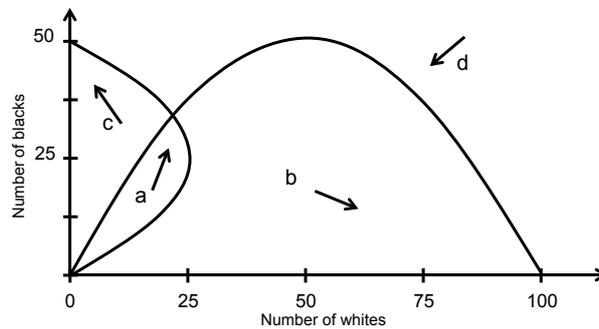
Schelling's bounded neighborhood model

- This is an alternative model. It allows to analyze in detail the movement in a neighborhood.
- Some assumptions are changed:
 - a) Actors care only about the color ratio in the neighborhood
 - b) Each actor has a maximal ratio of outgroup members that is *tolerated*. The actor moves if the ratio exceeds this value.
 - c) Those who are most dissatisfied move out first and the those who would like to move in first, move first.



Example:

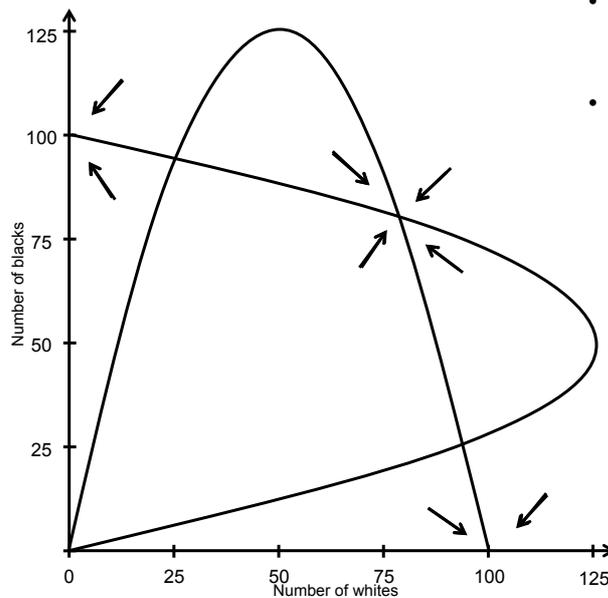
- There are 100 whites and 50 blacks
- This is the cumulative distribution of tolerance of the 100 whites
- Blacks have the same tolerance distribution



- a) There are whites and blacks who accept this distribution (more will move in)
- b) Blacks will move out and whites will move in
- c) Whites will move out and blacks will move in
- d) Members of both groups will move out until one of the lines will be reached

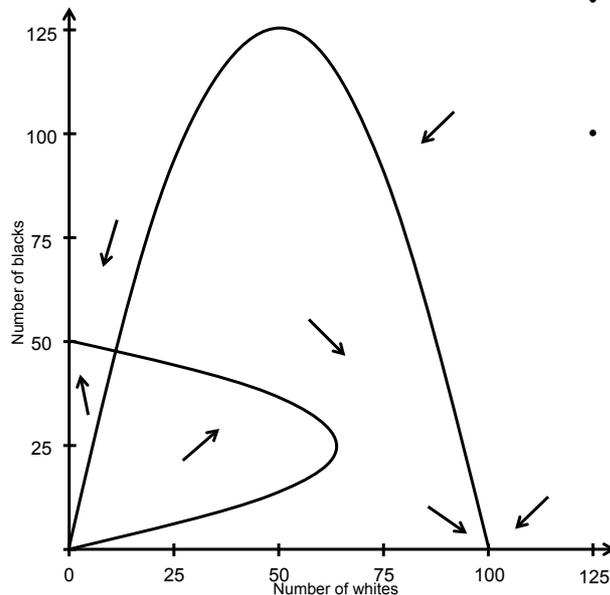
Despite the seemingly high tolerance, there are only segregated equilibria (all black or all white).

Alternative tolerance distributions



- All white and all black neighborhood remain stable
- However, there is a third equilibrium (80:80)

Alternative tolerance distributions

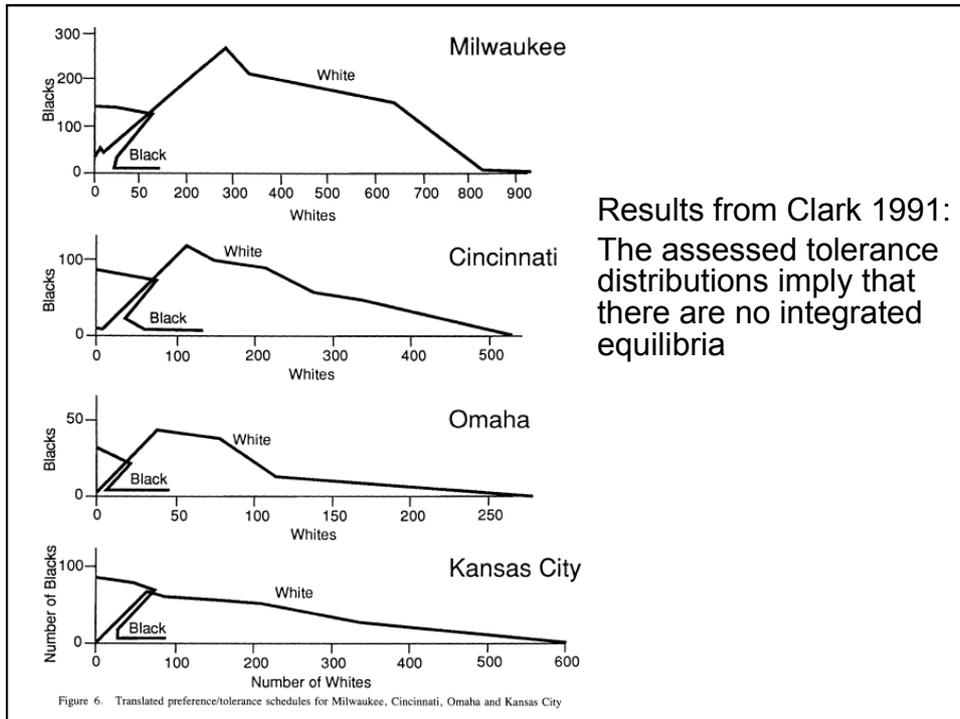


- Same tolerance distributions but one of the groups is smaller
- The mixed equilibrium disappears

Empirical tolerance distributions

- Survey question in a US study (see Clark 1991):

“Now assume you have been looking for a house or apartment and have found a nice place you can afford. It could be located in a neighborhood with different racial groups. What mixture of people would you prefer? Would you prefer a neighborhood that is ... (combinations of 100% percent white, 90% white and 10 % black, and so on through 100% black were read to respondent)”



How do American describe their “ideal” neighborhood composition (Clark and Fossett, 2008)?

	Black	Asian	Hispanic	White
8/8	64 (5.7)	153 (14.5)	104 (10.5)	106 (12.3)
7/8	21 (1.9)	25 (2.4)	32 (3.2)	27 (3.1)
6/8	43 (3.8)	60 (5.7)	59 (5.9)	59 (6.9)
5/8	96 (8.6)	108 (10.3)	87 (8.7)	88 (10.2)
4/8	176 (15.7)	224 (21.3)	150 (15.1)	123 (14.3)
3/8	276 (24.7)	214 (20.3)	218 (21.9)	208 (24.2)
2/8	275 (24.6)	165 (15.7)	195 (19.6)	143 (16.7)
1/8	100 (8.9)	49 (4.7)	69 (6.9)	46 (5.3)
0/8	67 (6.0)	54 (5.1)	80 (8.0)	61 (7.1)
	1118	1052	994	861

own race/ethnicity
 other race/ethnicity

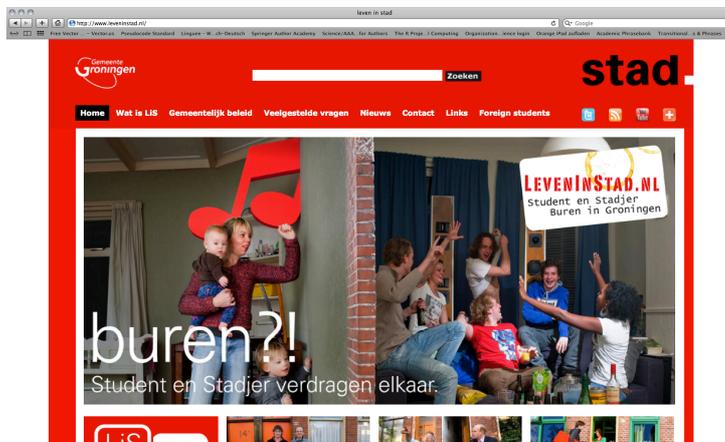
Fig. 2. Own-race preferences in an ideal neighborhood composition.

What can we about residential segregation?



Intervention 1: Restricting overrepresentation of a group in a neighborhood

- The city of Groningen (the Netherlands) tries to fight residential segregation of students. Groningen has about 190,000 inhabitants. 50,000 of the inhabitants are students (source: wikipedia.org, 2012).



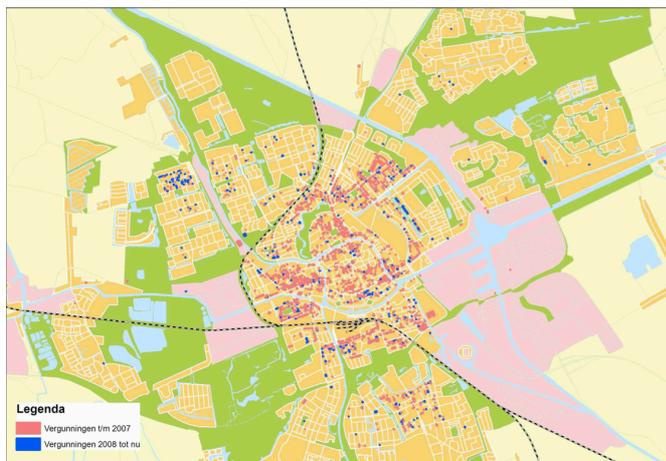
Doelstelling van ons kamerverhuurbeleid is drieledig:

1. zorgen voor een evenwichtige woningvoorraad, zodat er ook voldoende woningen beschikbaar blijven voor andere doelgroepen, zoals gezinnen en starters;
2. zorgen voor evenwichtige en leefbare wijken;
3. zorgen voor voldoende ruimte in de markt waardoor de groei van jongeren kan worden opgevangen.

Source: p. 3 of Jongerenhuisvesting Particuliere Kamerverhuur feb 2011-1

The intervention

In each street the share of flats with more than four rooms that is rented by more than 3 persons is restricted to 15 percent.



Each dot represents a flat that got a permission from the municipality

Source: city of Groningen, 2011

Discuss with your neighbor

What do you think about this intervention?
Will it help creating more mixed neighborhoods?
What are potential (negative) side effects?

You have 3 minutes.

Desegregation of US schools

- In the 1960s, James Coleman and other scholars were commissioned by the US Department of Education to write a report on educational equality in the US.
- Main findings:
 - School funding has little impact on school achievement of students
 - Instead, background and socioeconomic status of student has strong effect
 - Racial mixing increases school achievement of black students of lower status.



James S.
Coleman
(1926 - 1995)

The big question:
How can we increase racial equality?

Intervention: busing

- The study suggests that racial mixing increases school achievements of black students and, thus, increases racial equality.
- However, there was a high degree of school segregation (schools were either black or white and few mixed schools)
- To desegregate schools, busing was introduced. In this way, more black students went to schools in their school district which used to be predominately white.



Did desegregation policies work out?

TABLE 1
AVERAGE LEVELS OF METROPOLITAN SCHOOL SEGREGATION BY REGION

PREVALENCE OF DESEGREGATION MANDATES	1970		1990		2000	
	<i>D</i>	<i>SD</i>	<i>D</i>	<i>SD</i>	<i>D</i>	<i>SD</i>
All regions:						
No court orders	68.2	12.2	50.8	14.6	45.7	13.5
1%-49% of children under order	82.4	7.9	69.0	13.4	70.0	12.5
>49% of children under order	83.9	8.6	60.9	14.5	63.0	13.3
Overall	82.6	8.9	64.2	14.8	65.7	13.7

districts without
desegregation
policy

districts where
fewer than 50%
of students
were affected

districts where
more than 50%
of students
were affected

overall

- School desegregation also without intervention
- Trend appears to be equally strong for regions with many students who were affected by intervention
- Hence, it is questionable whether desegregation policies had an effect.

Data from Logan et al.
2008

What might have gone wrong?

- Busing was used in mixed school districts where the school composition did not match the racial composition of the district.
- Coleman (1975) himself argued that in large cities desegregation may motivate whites to move to “white” school districts where there are no desegregation programs (because school composition matches composition of district).
- This tendency is called “white flight”.
- Results from Coleman’s study:

1. Proportion of whites who would leave in 2 years if there were no blacks (1970) and no increase in black schoolmates: 2%.
2. Additional proportion of whites who would leave in 2 years if there were 50% blacks (1970): 7%.
3. Additional proportion of whites who would leave in 2 years if increase in black schoolmates of the average white were 5% in preceding 2 years: 10%.

For a city 50% black in 1970, with a 5% increase in black schoolmates of whites, the migration in 2 years is 19%, 2% + 7% + 10%. Thus from these preliminary results, it appears that the impact of desegregation, in these large cities, on whites’ moving out of the central city is great. The governmental actions, reducing segregation within districts, provokes rather strong individual actions which partly offset that effect.



LAO
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Empirical support for white flight

TABLE 2
AVERAGE LEVELS OF WITHIN-DISTRICT SEGREGATION BY REGION

PREVALENCE OF DESEGREGATION MANDATES	1970		1990		2000	
	D	SD	D	SD	D	SD
All regions:						
No court orders	57.3	14.5	30.0	12.2	28.9	10.0
1%–49% of children under order	77.0	12.0	48.6	16.4	48.8	14.0
>49% of children under order	81.9	9.4	51.4	16.2	52.6	15.2
Overall	78.5	12.4	49.0	17.3	49.5	15.4

- This measures to which degree school composition maps composition of district

Segregation decreased even without interventions

TABLE 3
AVERAGE LEVELS OF BETWEEN-DISTRICT SEGREGATION BY REGION

PREVALENCE OF DESEGREGATION MANDATES	1970		1990		2000	
	D	SD	D	SD	D	SD
All regions:						
No court orders	44.0	22.1	45.5	17.3	46.5	18.3
1%–49% of children under order	59.5	17.7	63.8	15.8	64.2	15.6
>49% of children under order	38.0	22.7	43.8	17.7	46.5	16.2
Overall	48.6	23.0	53.6	19.6	55.3	18.2

- This measures the degree to which districts of a metropolitan area have similar racial composition

no changes without interventions

but slightly stronger increase in segregation between districts with interventions

- The white-flight argument is debated. However, a recent overview concluded that “the preponderance of evidence now suggests that school desegregation is a push factor for whites” (Logan et al. 2008)
- White flight suggests a decrease in school segregation within school districts but simultaneously an increase in segregation between districts.
- Our theories make implicit **ceteris paribus assumptions**. In this case, an additional process (white flight) led to increased segregation between school districts. This hampered the effects of busing.
- What is more, some scholars argue that busing might have even triggered/increased white flight.



Aims of this lecture

- Understand the micro-macro problem
- Understand Schelling’s model of residential segregation
- Introduction to NetLogo

Literature



References

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