Experimenting with cities, integrating Agent-Based Models and GIS: Applied to segregation

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Outline

- Introduction
- The Generic Agent Based Model
- Application
 - Segregation Model
- Conclusions

What is Agent Based Modelling?

- Agents:
  - Individuals which are not centrally governed (focus on the individual).
  - Dictate their own rules (i.e. have a behaviour).
  - Don't have to be rational.
  - Capable at modelling bottom up processes.

- Example applications: urban growth, economics, traffic simulation, disease transmission & pedestrian modelling.

If <cond> then <action1> else <action2>

Inanimate agents

Animate agents

Artificial World
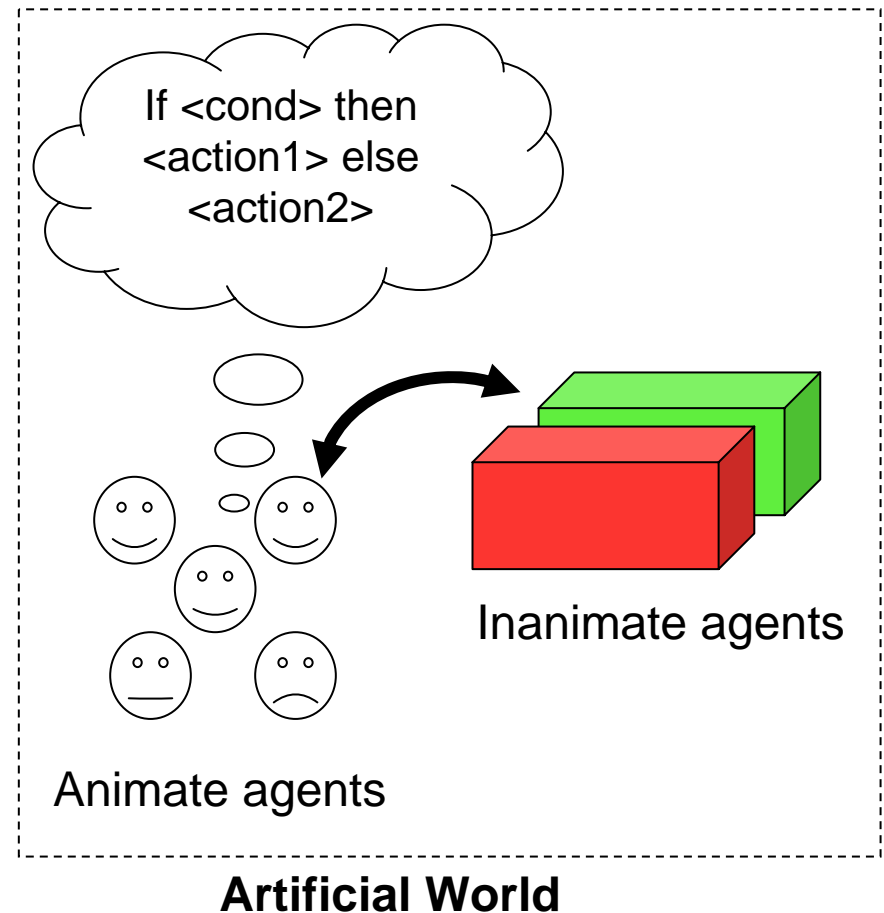
Example of a simple ABM: Traffic Simulation

- Models the movement of cars on a road
- Each car follows a simple set of rules:
  - If there's a car close ahead, it slows down.
  - If there's no car ahead, it speeds up.
- Demonstrates how traffic jams can form without any obvious incident.
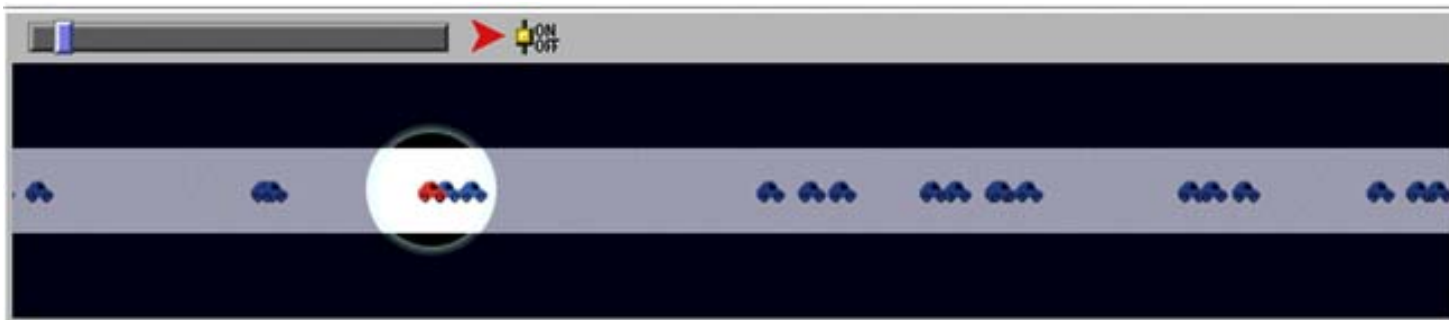
Aims of the research:

- Develop 'tools to think with', scenario testing.

- Incorporate GIS into ABM.

- Explore micro interaction => emergent patterns.

- Develop simple models '*of their type*' that can easily be extended into examining different types of urban phenomena.

Generic ABM

- A series of tools for:
  - Reading in data
  - Displaying data and agents
  - Movement of agents
  - GIS operations
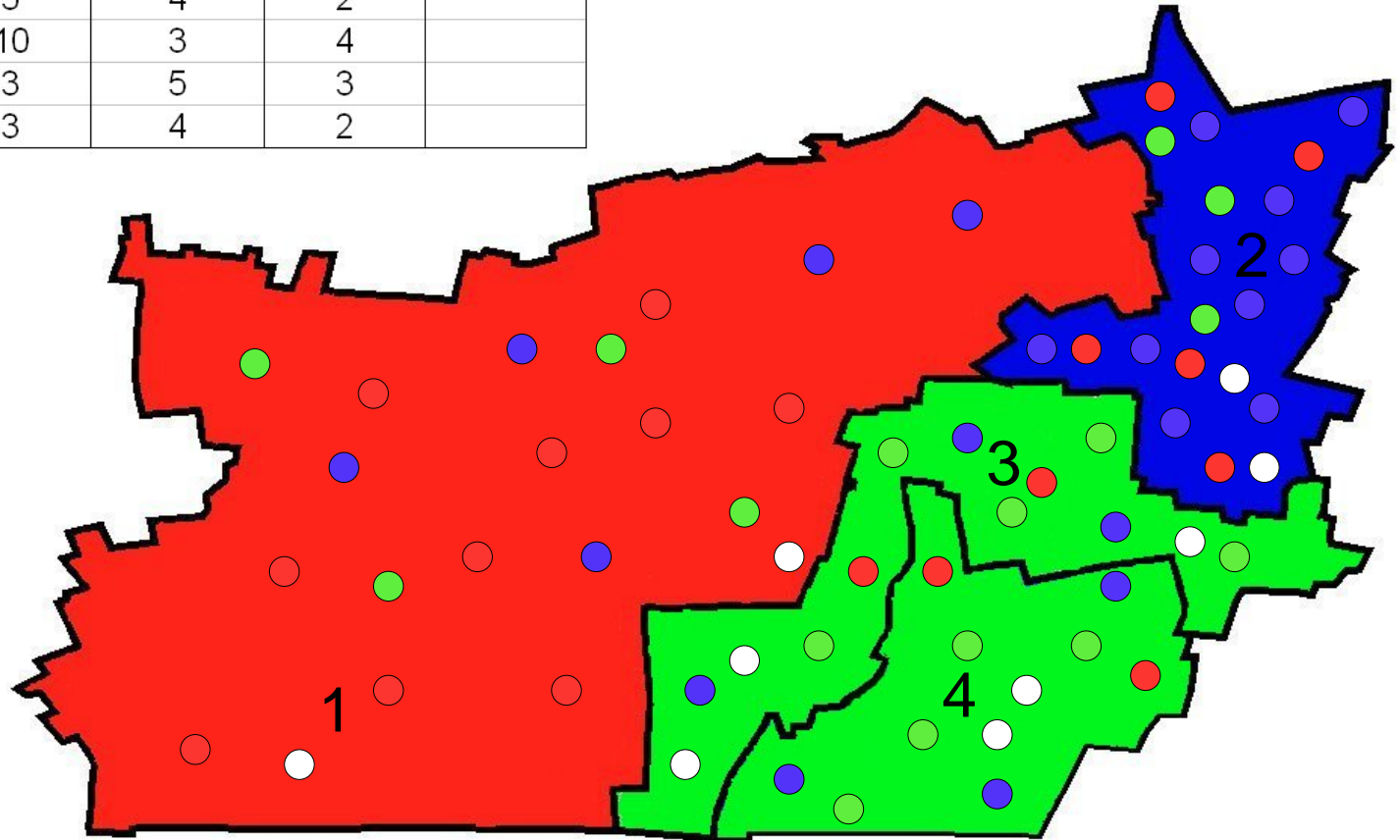 - User Interaction, parameter setting
  - Data capture
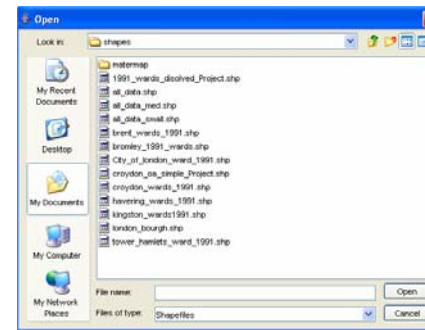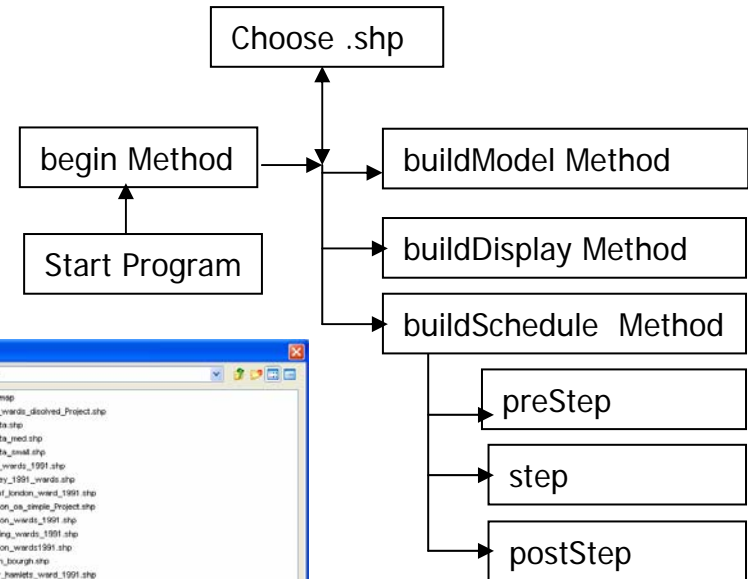
Changing the rules changes the model.
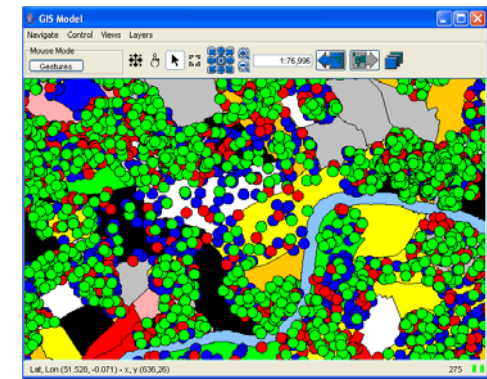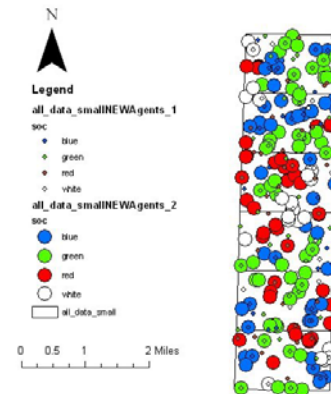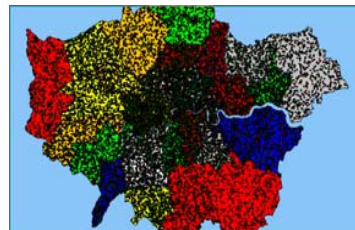
Reading in the data & building the model

Ward	No. Red	No. Blue	No. Green	No. White	Other info
1	10	5	4	2	
2	5	10	3	4	
3	2	3	5	3	
4	2	3	4	2	

Actions of individual agents will create changes in their physical environment.

Application of Generic ABM: Segregation

Segregation Background:

- Many different types.
- Seen in many cities=> marginalization.
- Hard to find clear examples taking place.
- Schelling showed that with mild preferences to locate amongst like demographic or economic activity groups, strict segregation would emerge unknowingly.
- Good example of emergent phenomena.
- Based on local neighbourhood searching

Segregation Model Structure: Residential Agents

Agents Attributes

	No. of agents	Percentage
Red Agents	4	50%
Blue Agents	2	25%
Green Agents	2	25%

Resident id: 27

Agent ID: 27

Lat: 51.320675

Lon: -0.521941

Age: 44

Happy: true

soc: red

Moved: 0

Red agent preferences	
Red with Red	>= 50% Red
Red with Blue	< 30%
Red with Green	< 50%
Red with White	< 10%

Calculating neighbourhoods

Example of Agent preferences

Model Structure: Urban Environment

- The GIS layer. Contains information from the data file.

- Used to calculate population density, contains the residents

- Attributes are changeable: social class and landuse depending on the type of residents within.
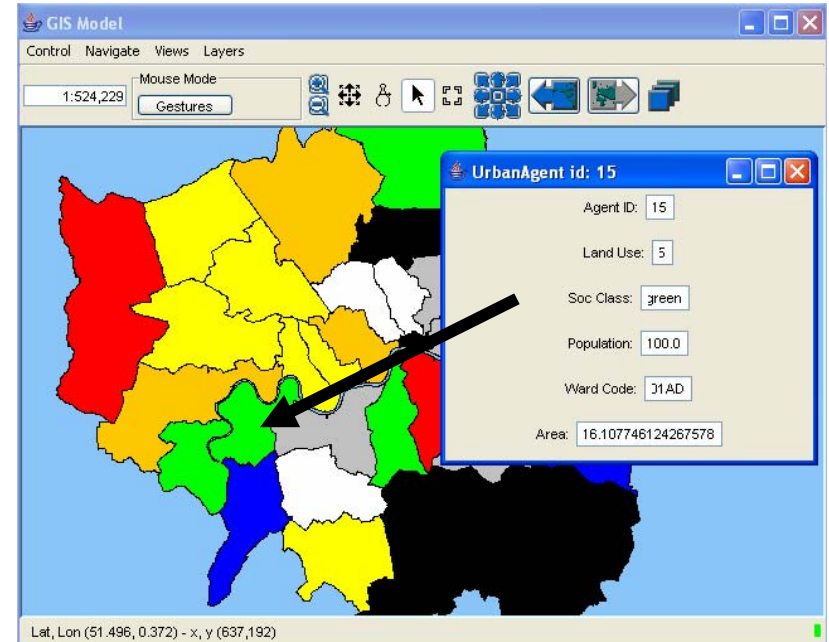
|	Resident Agent social class	Urban agent	Colour
1	Green % highest	Green	Green
2	Red % highest	Red	Red
3	Blue % highest	Blue	Blue
4	White % highest	White	White
5	Green & Red % equal	Mixed	Yellow
6	Green & Blue equal	Mixed	Orange
7	R & B || W & B || R & W || G & W	Mixed	Grey
8	All other combinations	Mixed	L Grey
9	Empty (no residents)	Empty	Black

Agents in Geographical Space
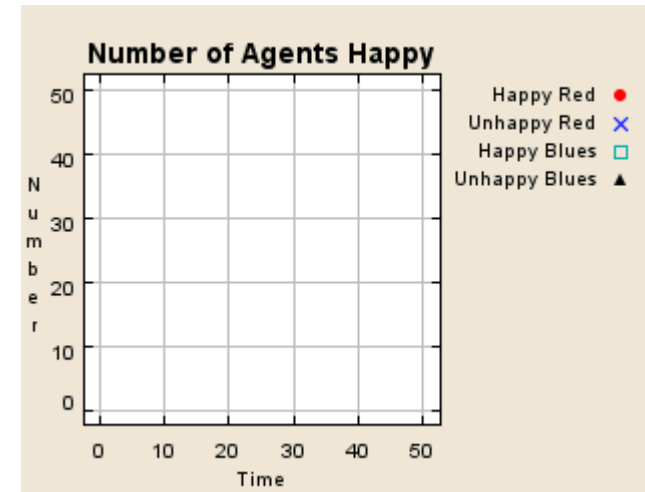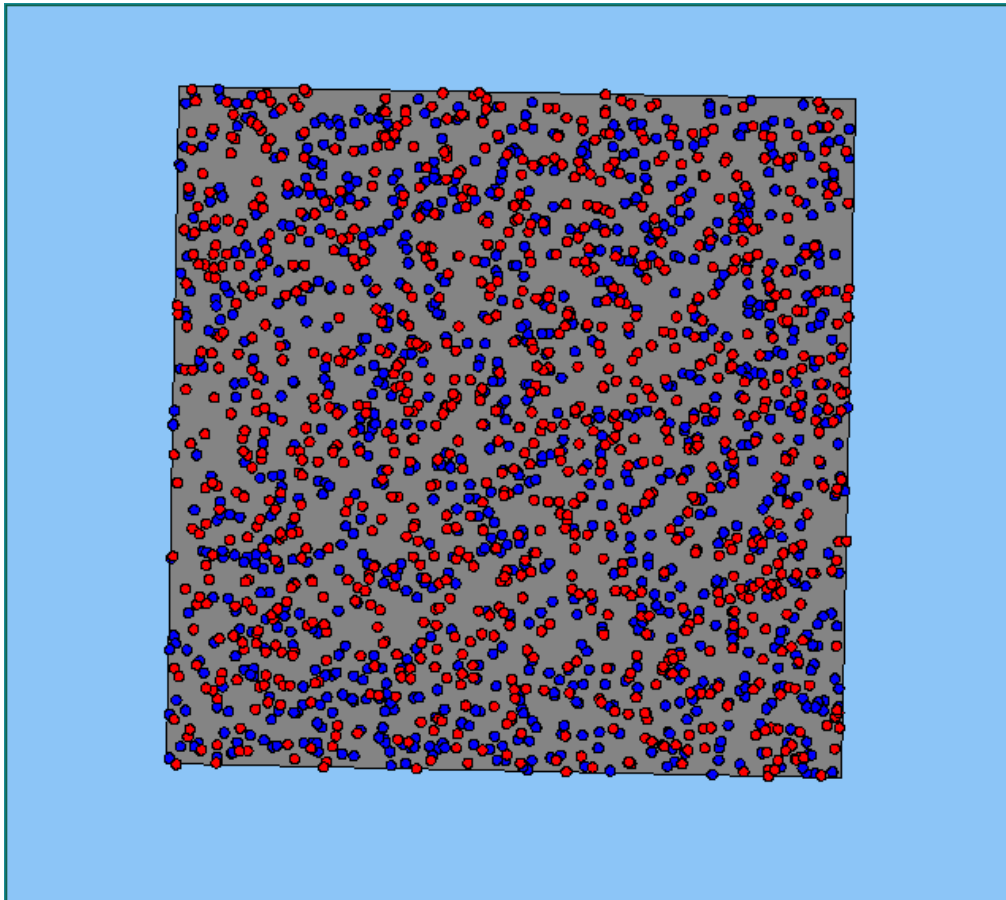
•Agents want areas where 30% neighbours are of same type.

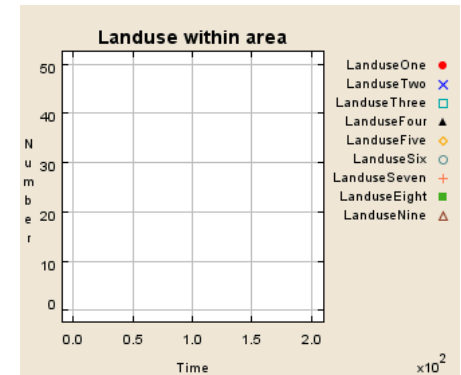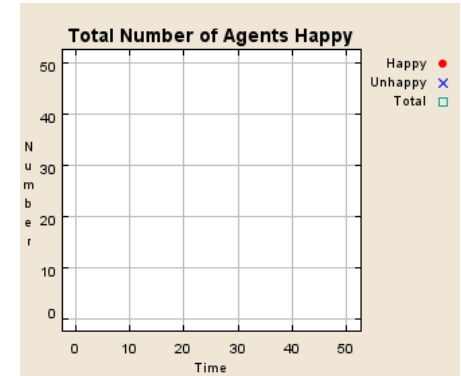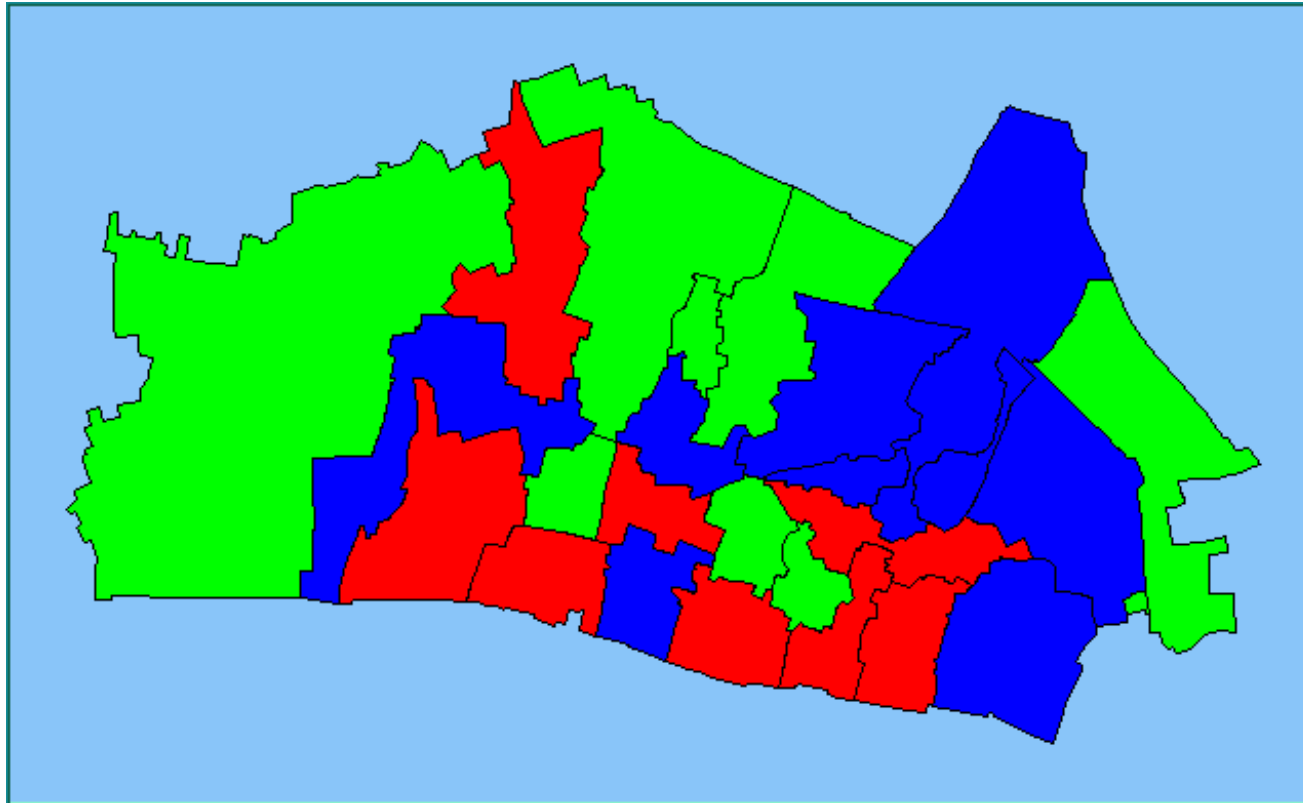# Agents in Geographical Space: Two Areas
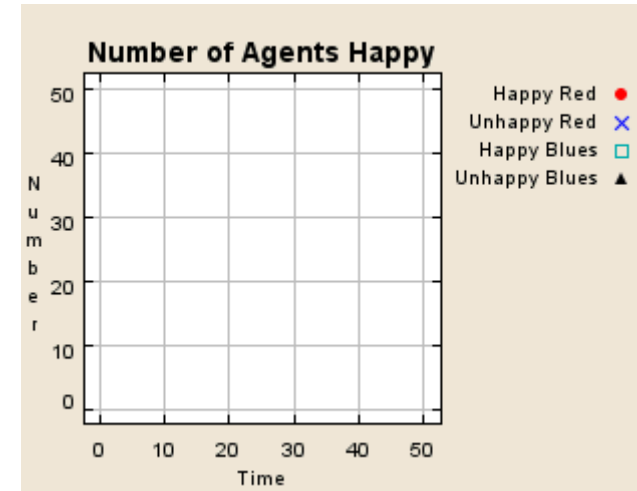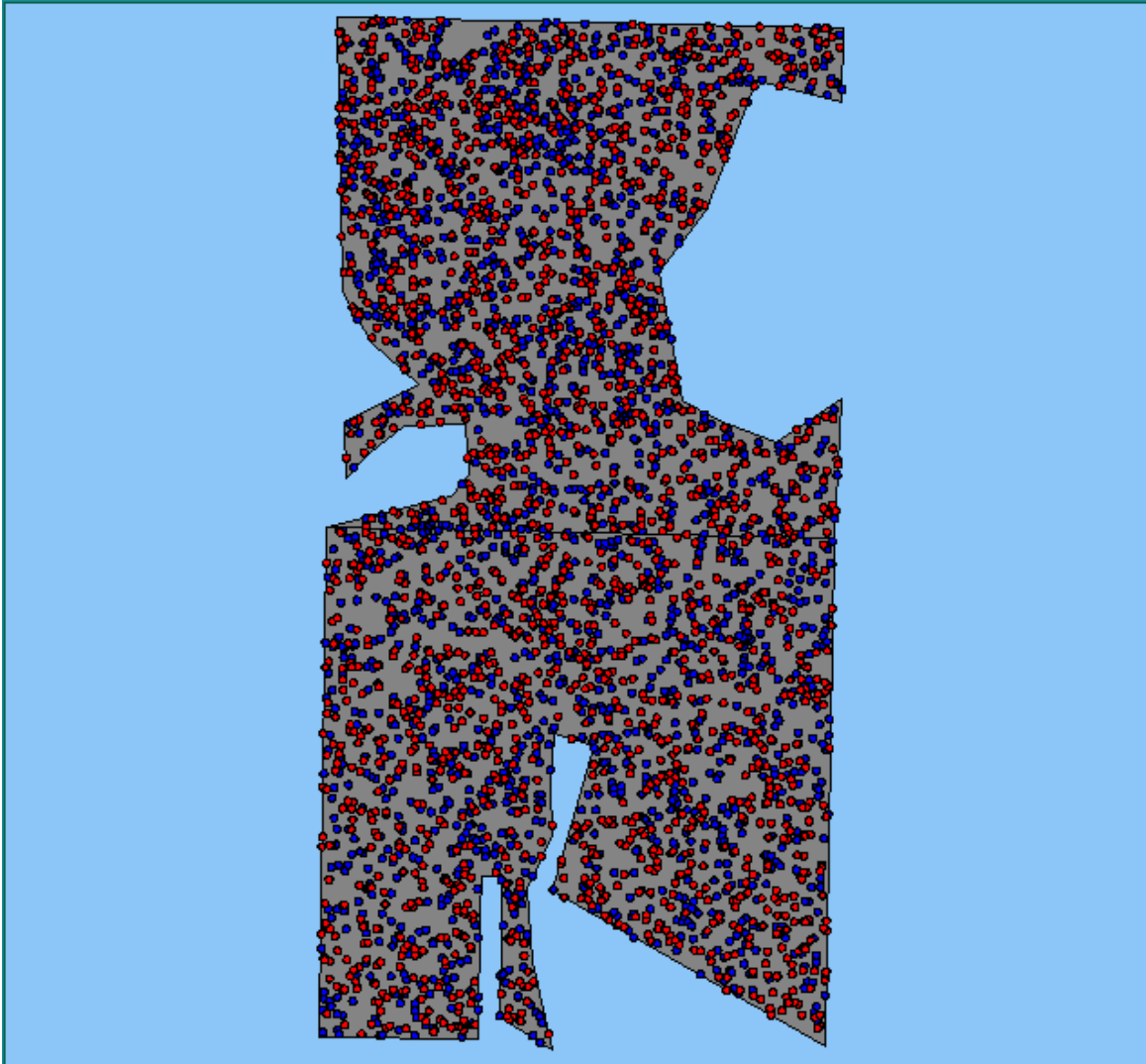
- Initially even number of Reds and Blues in both areas
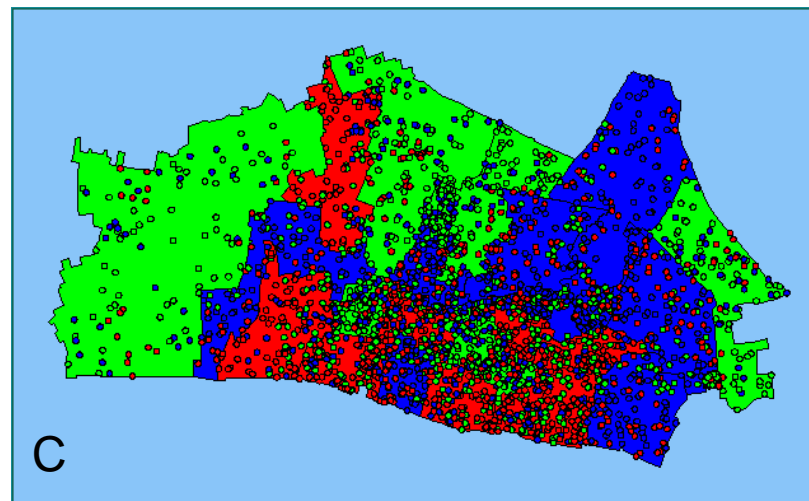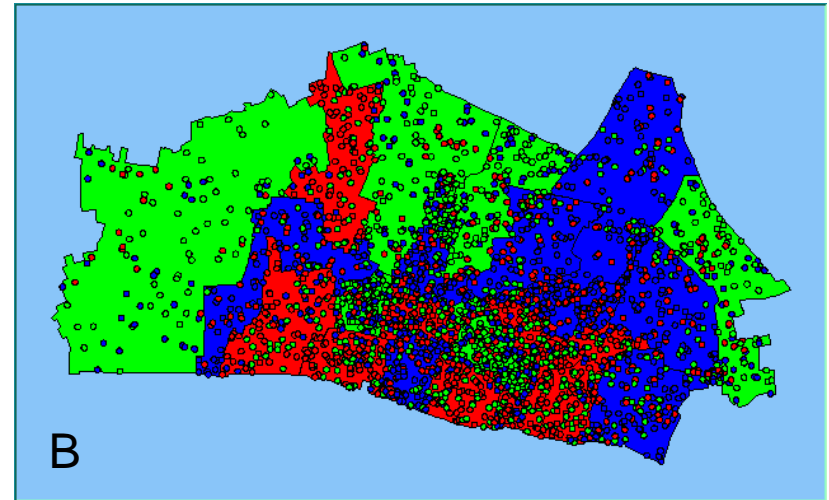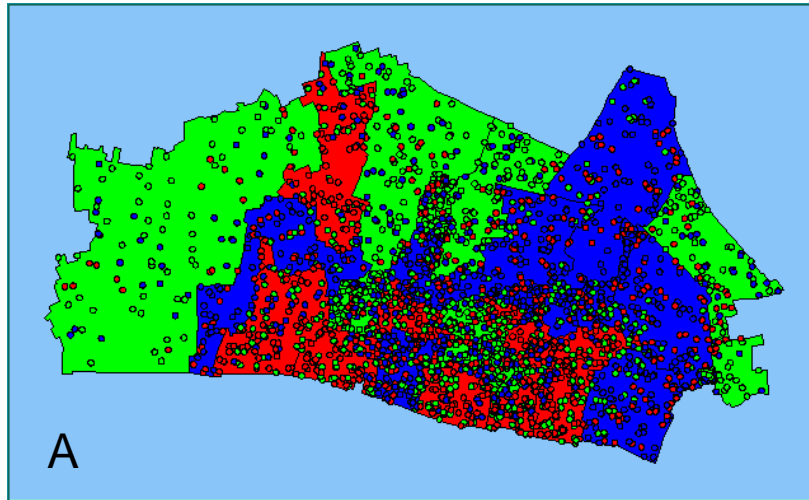- Agents want areas where 40% neighbours are the same

Simulation: Resilience to change and Stabilisation
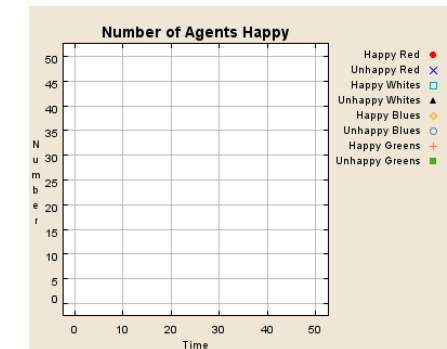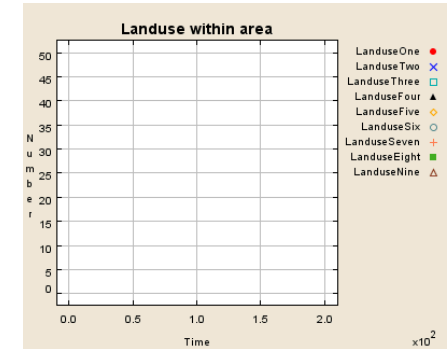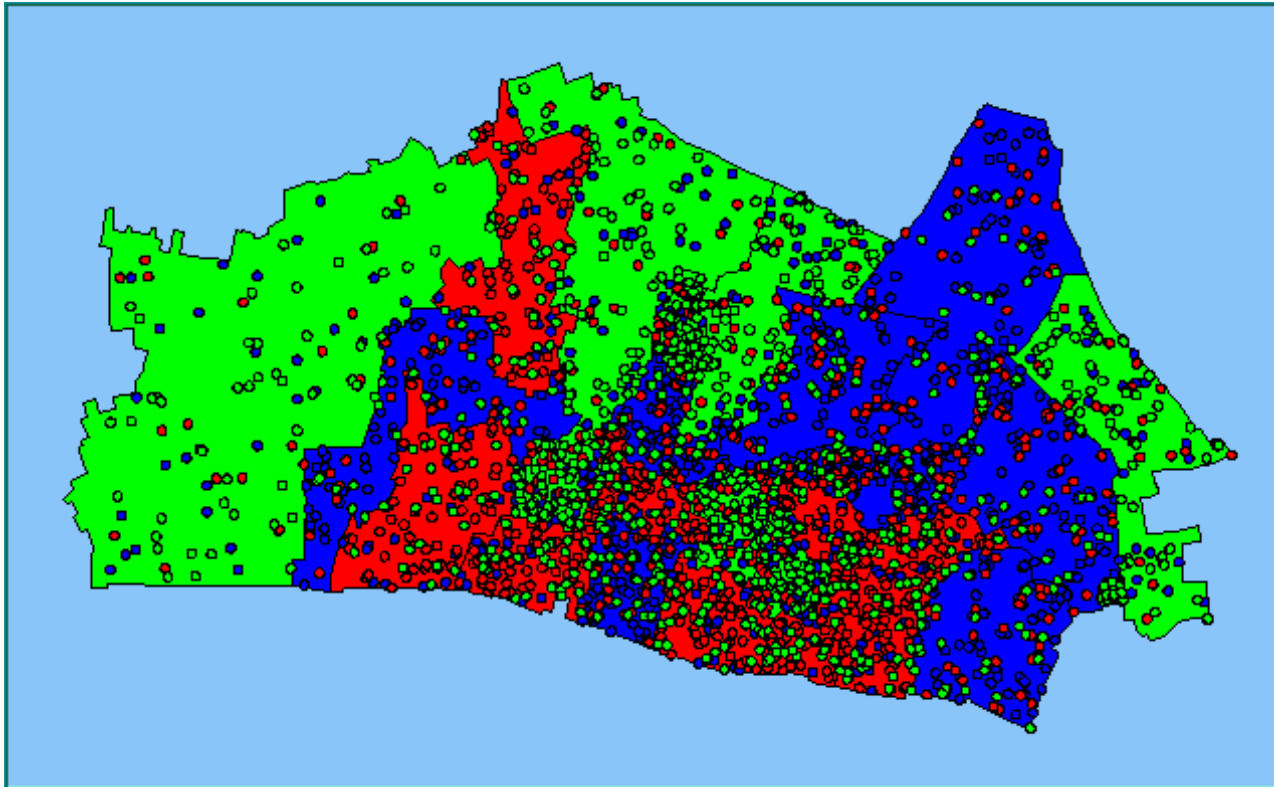
Simulation: Resilience to change and Stabilisation

Comparing Simulations for Stabilisation

	Iterations	Number of moves
A	5	182
B	8	203
C	3	177

- Initial conditions matter => multiple runs

Segregated Neighbourhoods
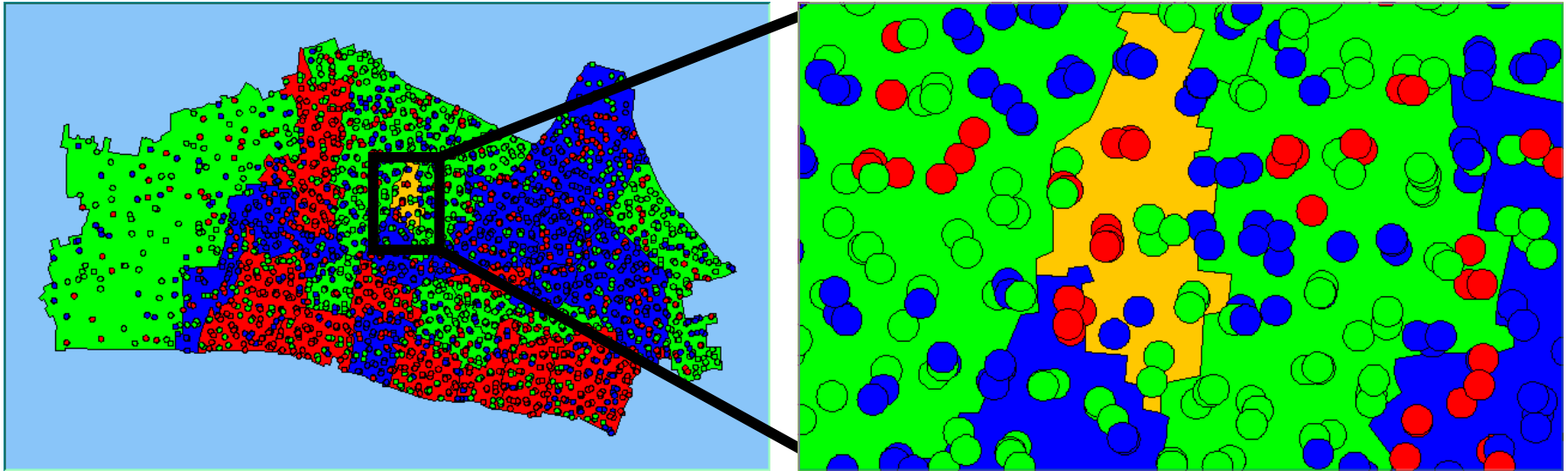
- Yellow area is a "mixed" ward with equal numbers of green and red agents
- Micro clusters will not be visible if we only consider the ward level data

Conclusion

- Simple model structure was highlighted integrating ABM and GIS.
- With alterations new models can be easily created.
- Application:
  - Segregation model: mild preferences=> segregation
- Further work:
  - Developing a location model
  - Scenario and sensitivity testing
- For more info: www.gisagents.blogspot.com