Agent-Based Modelling and Burglary in Leeds

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Outline

Modelling crime: the problems

Agent-based modelling and crime

The model

Conclusion

Future work
Journey to Crime

Local in nature

Anchor points

Environmental Criminology

- Opportunity Theory
  - attractiveness and accessibility
- Routine Activities Theory
  - convergence in space and time of a motivated offender and a victim in the absence of a capable guardian
Burglary Locations
Problems with statistical methods

Spatial Interaction / Microsimulation

- Problems investigating human behaviour
- Problems with predictive analyses
Why ABM?

More “natural” for social systems

Investigate interactions at micro level

Ideal for routine activities theory

Main problem:
  • Modelling “soft” human factors
Study Area: Leeds

North-East England
(West Yorkshire County)

700,000 people

Large University and student population
Study Area: Leeds

Indices of Multiple Deprivation

- Health/Disability
- Employment
- Income
- Education/skills
- Living environment
- Barriers to services
Safer Leeds

2001-2004 Crime Data
• Extract burglaries in Leeds

Census data - http://www.census.ac.uk/casweb/

Boundary data - http://edina.ac.uk/ukborders/
Simple introductory model - predict where offenders travel to

Create an agent for each crime

• Represent crime events, not offenders
• “Home ward” - known
• “Crime ward” - unknown

To choose a crime ward:

• Each agent assigns an overall attractiveness to each ward
• Most likely to choose most attractive ward
Two Crime Theories

Opportunity Theory

\[ L_i = \frac{A \times socio\text{economic}_i + B \times num\text{Students}_i + C \times thouse_i}{D \times distance(i, h)} \]

Routine Activities Theory

- Improved distance decay
- OA level

\[ L_i = \frac{A \times socio\text{economic}_i + B \times num\text{Students}_i}{C \times distance(i, h)^D + E \times distance(i, h) + F} \]
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Model Error

Standardised Root Mean Square Error

- Compare observed and expected matrices
- 0 indicates identical matrices

\[
\sqrt{\frac{\sum (y_i \bar{y} - y_i)^2}{n}}
\]
Results - SRMSE

Best SRMSE:

- 1.3
- Using Routine Activities on Output Area data

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Results – Current Analyses

Difference in observed and predicted crime levels

- Headingley
- Halton
Results – “What-if” Analyses

Clarence Dock
Simple Model Conclusions

Support for Routine Activities Theory

Support short offender travel distance (~3 km)

Model able to perform explanatory and predictive analyses
Future work

More complex ABM

• Victims, capable guardians etc
• Detailed environment
  - Perceptions of space: cognitive models
• Human Behaviour
• Social networks
Future work - detailed environment

Masterap
• Ordinance survey data
• Houses, gardens, roads, rivers etc.

Incorporate with a GIS
Thankyou

Paper
  • Journal undecided

Questions?
Suggestions?

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