Determining internal migration factors in a demographic microsimulation via mixed-cell cellular automata

Maria Teresa Pulido, Nik Lomax, Luke Archer

University of Leeds / Leeds Institute for Data Analytics

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Outline

1. Internal Migration
2. Microsimulations
3. DAEDALUS and SPENSER
4. Mixed-Cell Cellular Automata
5. Summary

Internal Migration

Component of Population Change:

- Birth
- Death
- International Migration
- Internal Migration

Internal Migration is the most challenging to model

- Time-varying rates
- Less accurate data
- Fluctuating factors
- More variables (origin and destination)

Factors for Internal Migration

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Factors for Internal Migration

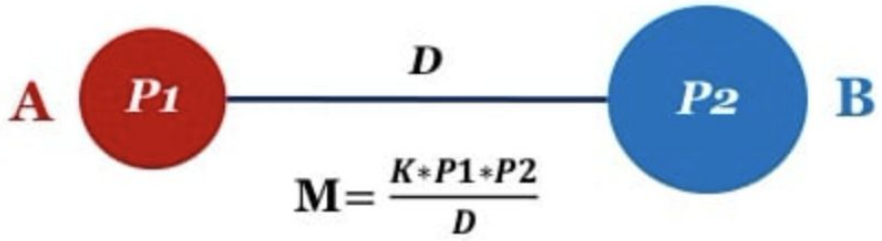
Size

Distance

Gravity Model

by Zipf in 1946

Based upon Newton's law of gravitation



$$M = \frac{K * P1 * P2}{D}$$

D= Distance between the two places

P1= Population of place A | **P2**= Population of place B

K= A constant relating volume of migration at any specific time

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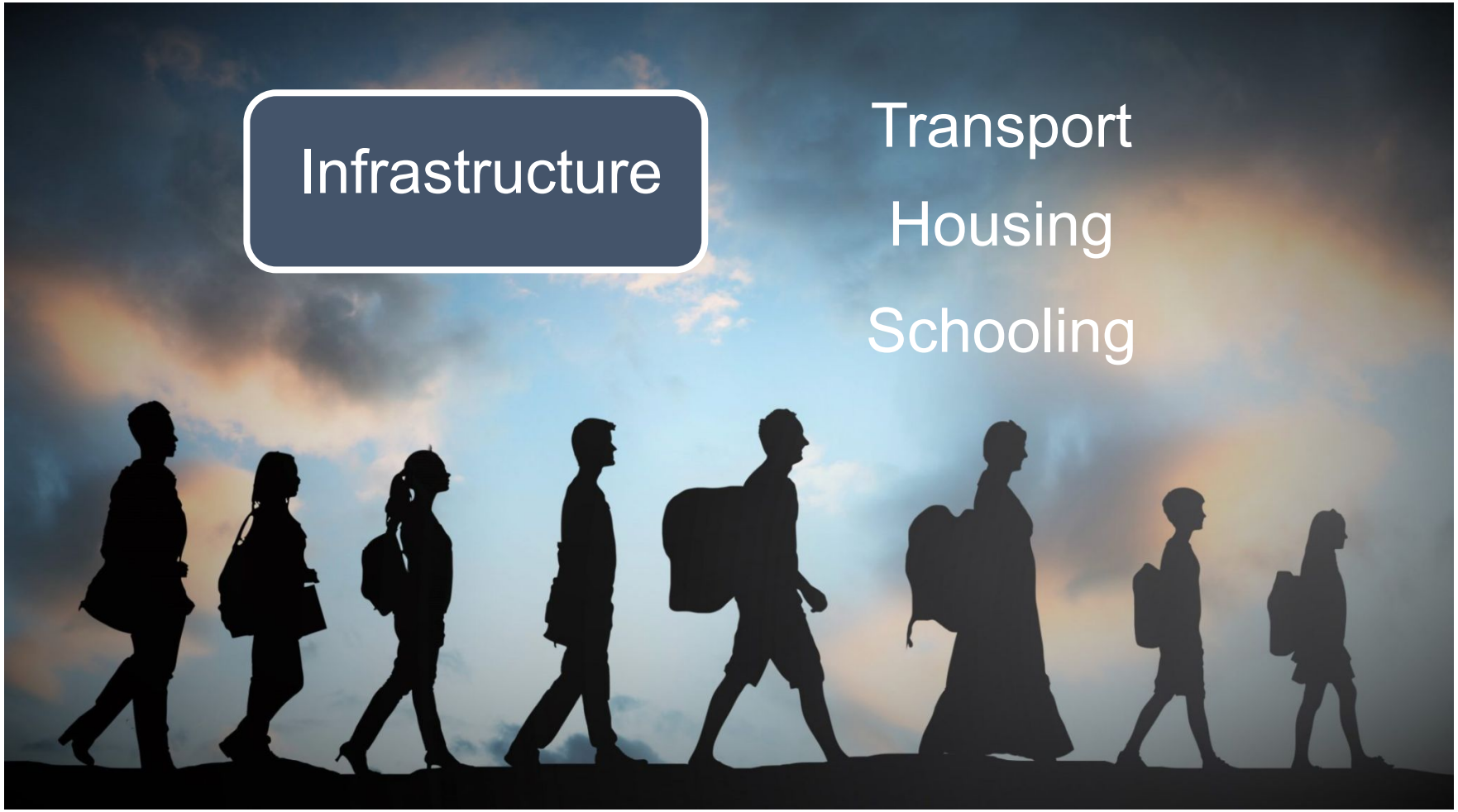
Factors for Internal Migration



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Internal Migration in Microsimulations

- The probability for internal migration is calculated per individual

- Calculations are based on data (migration)

  Rather than the factors behind the data

- Each location or cell holds only one value at a time

Internal Migration in Microsimulations

Assign individual
with probability of migrating

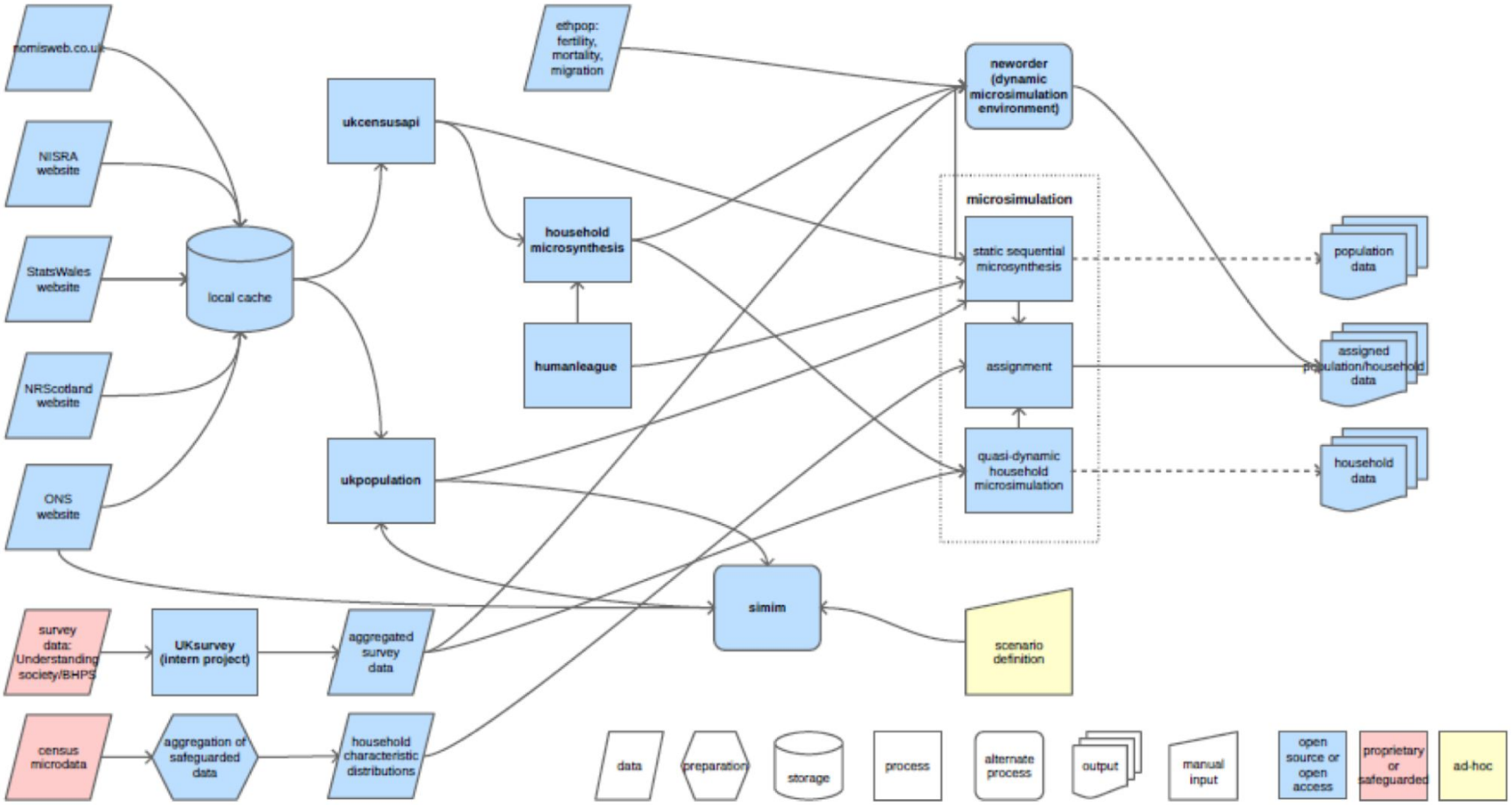
If individual is migrant,
feed in to distribution matrix
(based on data)

DAEDALUS and SPENSER

- DAEDALUS is a novel dynamic spatial microsimulation model for small area population projections

- The SPENSER (Synthetic Population Estimation and Scenario Projection Model) project is a collaboration between Leeds Institute for Data Analytics and the Alan Turing Institute

SPENSER Workflow



https://dafni.ac.uk/wp-content/uploads/2020/05/dafni-pilot-4-dafni-hosts-population-forecast-model.pdf

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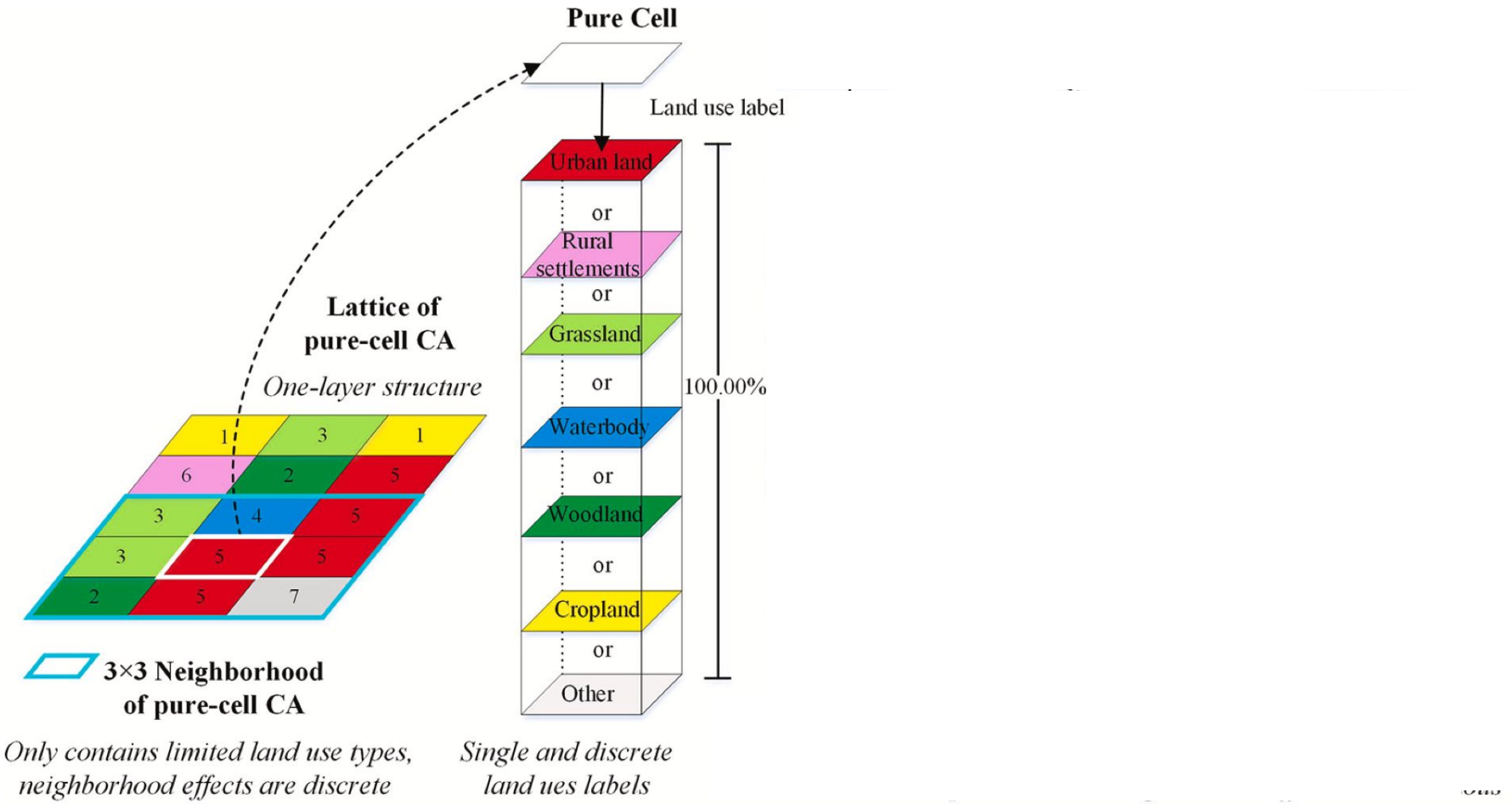
Cellular Automata



Liang X., et al. 2021. *Landscape and Urban Planning*, 205:103960.

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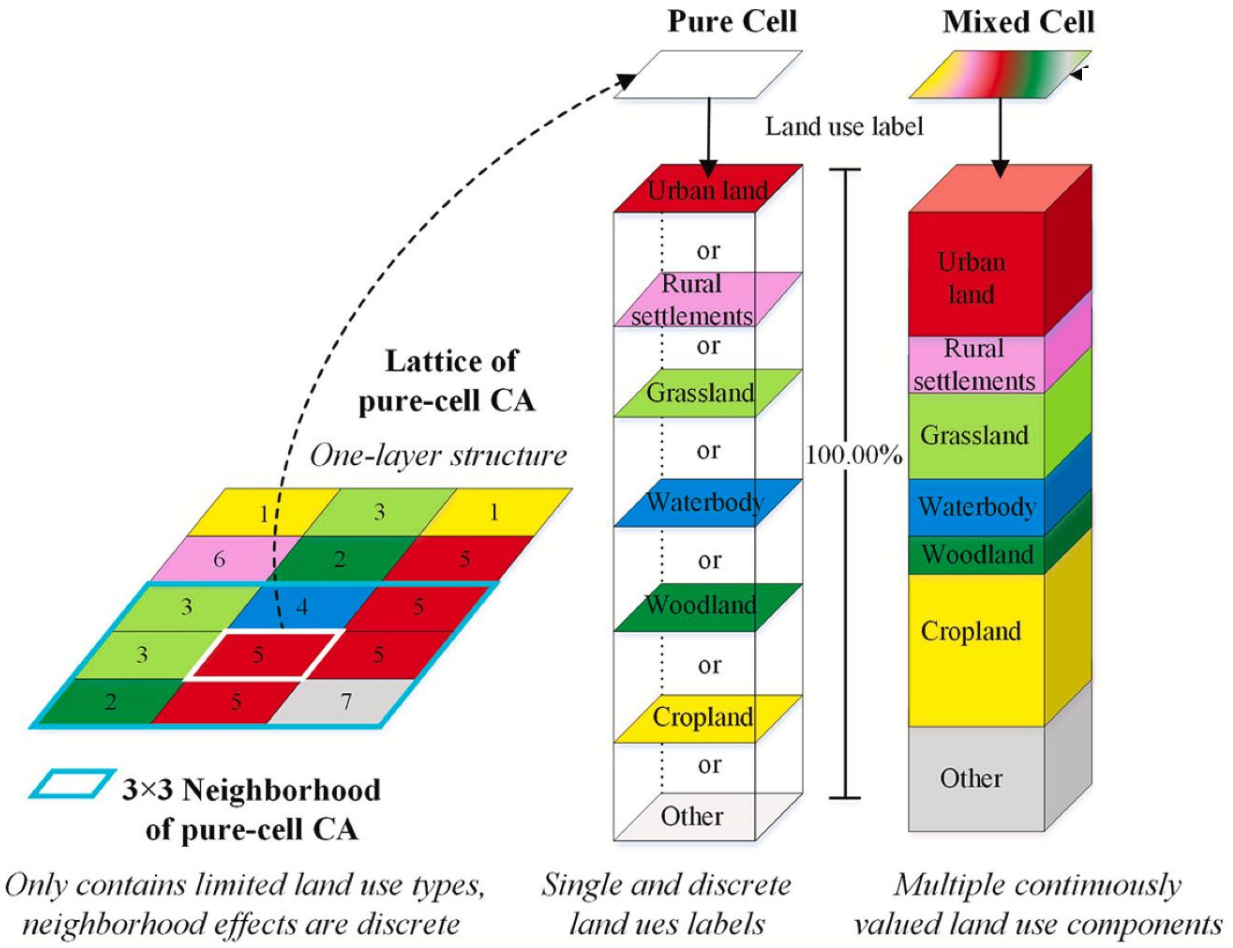
Mixed-Cell Cellular Automata (MCCA)



Multiple properties per cell

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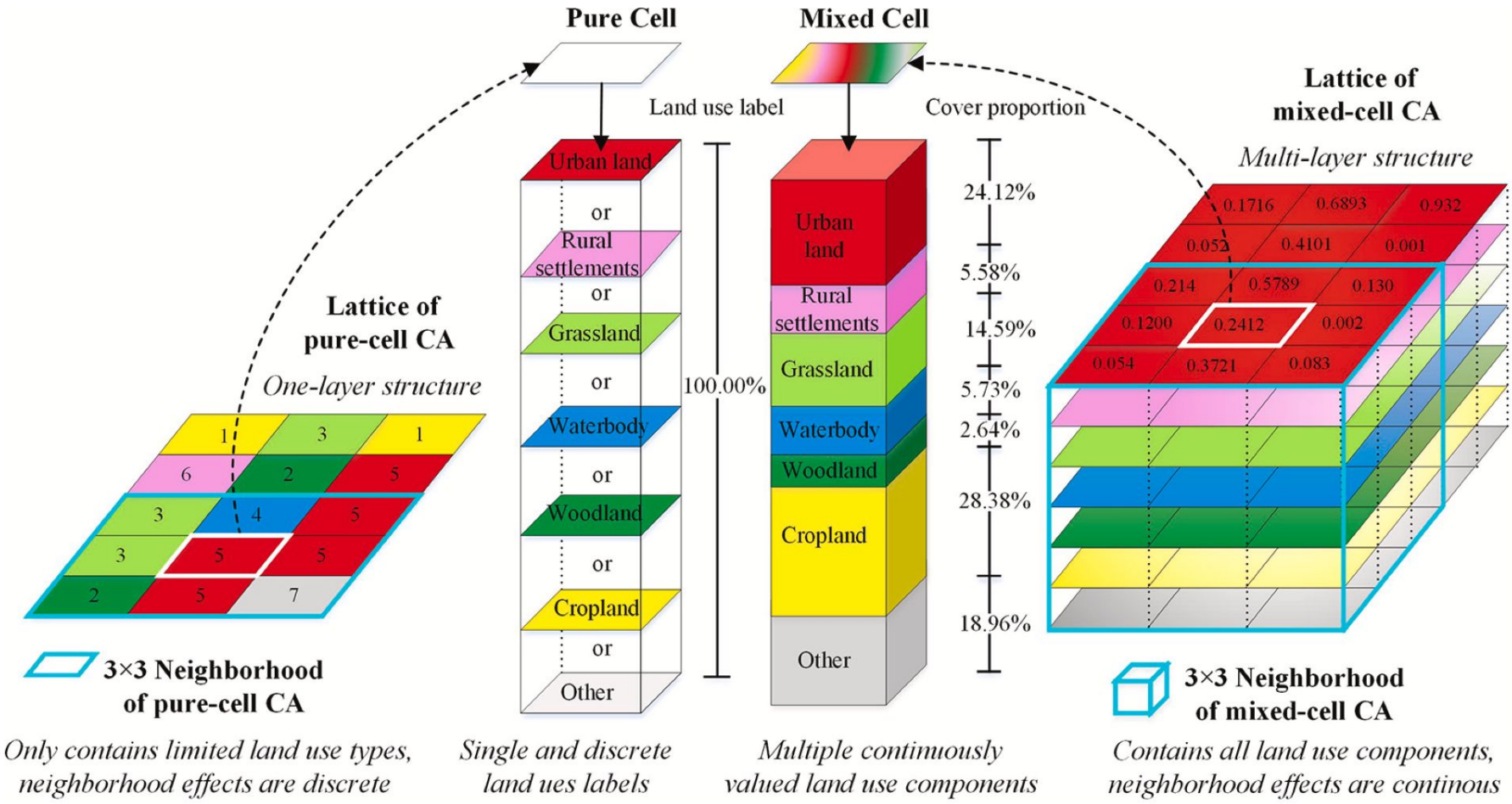
Mixed-Cell Cellular Automata (MCCA)



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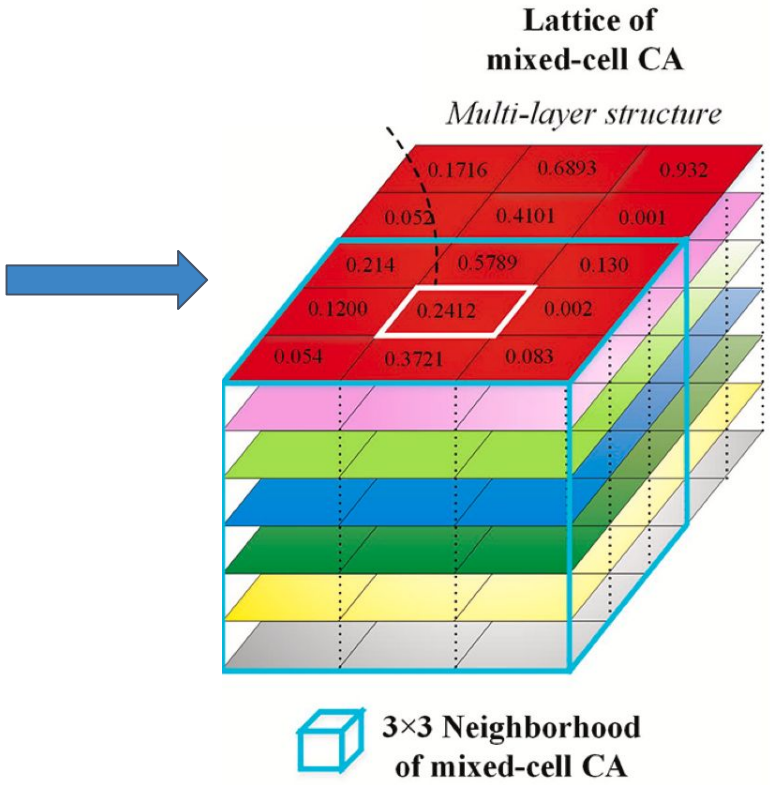
Properties → Internal Migration factors



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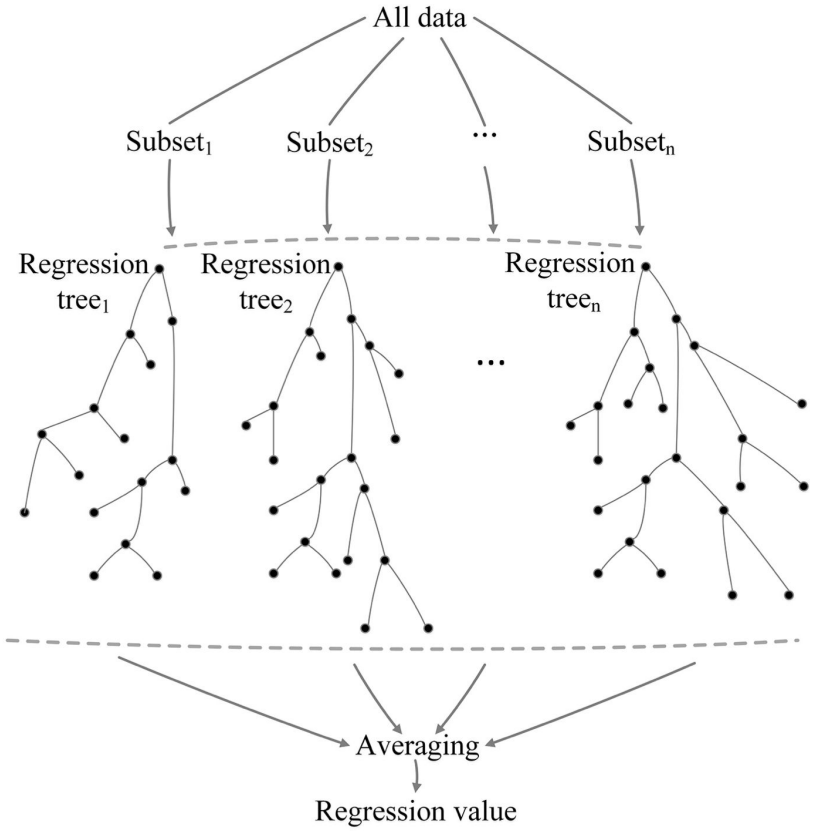
MCCA in DAEDALUS

- Cell selection via Random Forest Regression

- Test various scenarios via weights
  - Uniform for all factors
  - Dominant factor + others



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MCCA in DAEDALUS

- MCCA will be included in the decision-making process for DAEDALUS
- MCCA amends the probability distribution within the matrix based on cell values(attractiveness)
- We will be able to model and compare various scenarios

Summary

The use of mixed-cell cellular automata enables us to give more realistic, dynamic yet straightforward improvements to modelling internal migration in microsimulations.

Thank you.