

# Towards a 'pattern language' for spatial simulation models

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New Zealand

AAG  
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## 1 A new book

- Reasons for writing it
- Overall outline

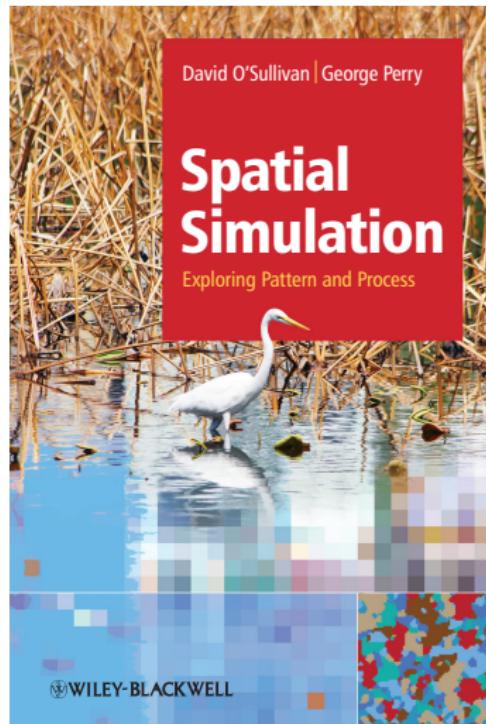
## 2 'Building-block' models

## 3 Towards a pattern language

- What is a pattern language?
- A preliminary example
- Outcomes

## 4 Concluding remarks

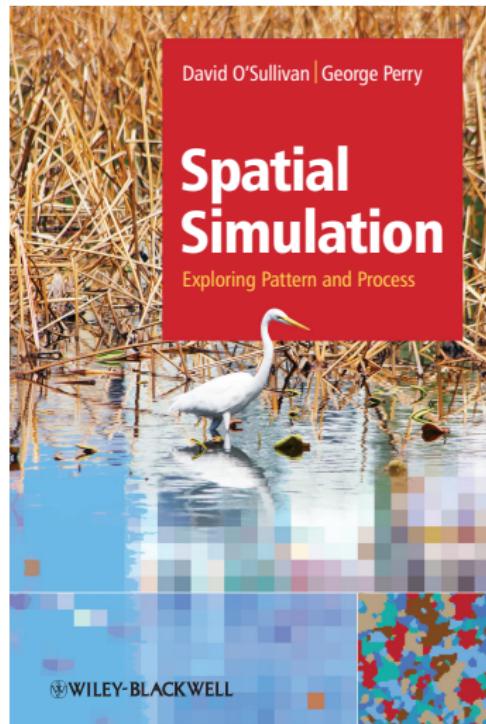
# *Spatial Simulation: Exploring Pattern and Process*



## Why we wrote this book

- Students (and many others) find it hard to get started
  - e.g., trapping on a pest-free reserve island
- Primary literature on simple models is challenging (mathematics, physics, statistics)
- There is no good introduction
- A crazy idea that there are many models but that they might be built from only a few simple building blocks

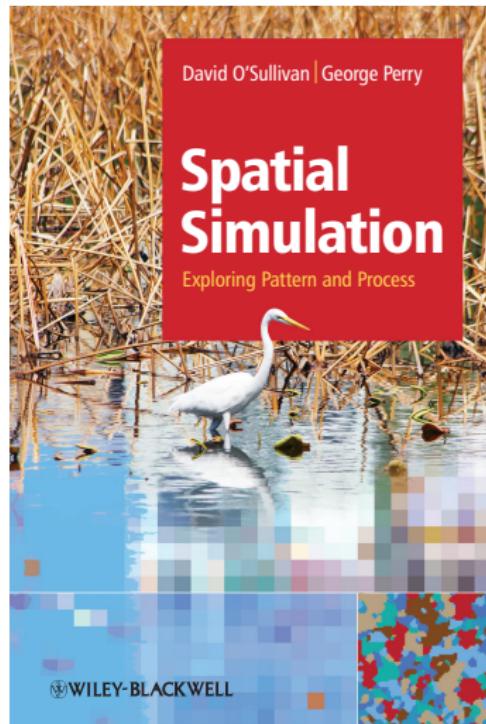
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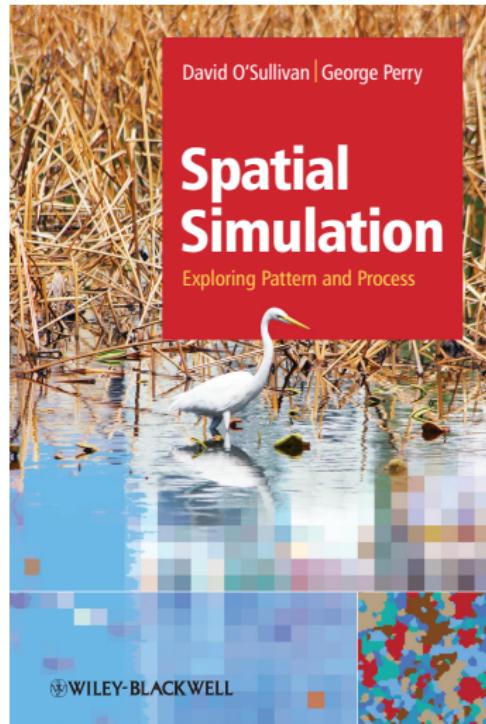
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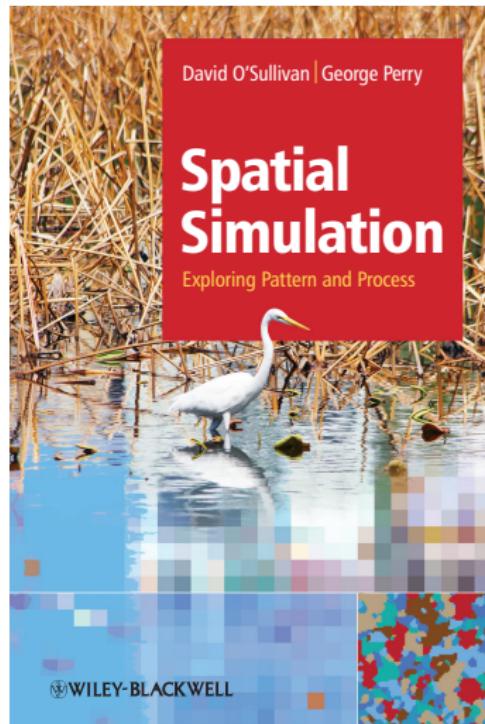
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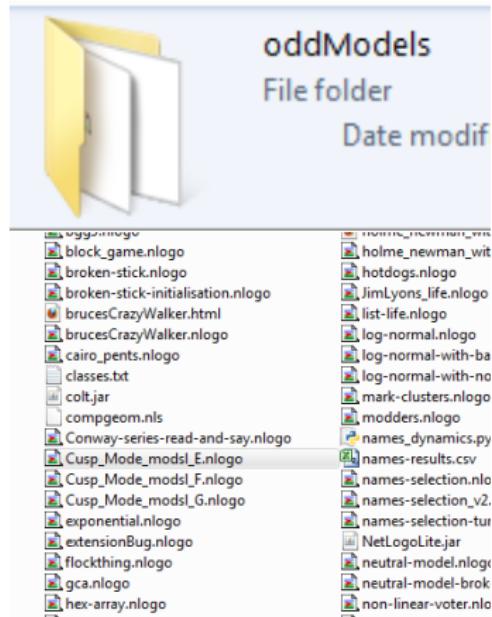
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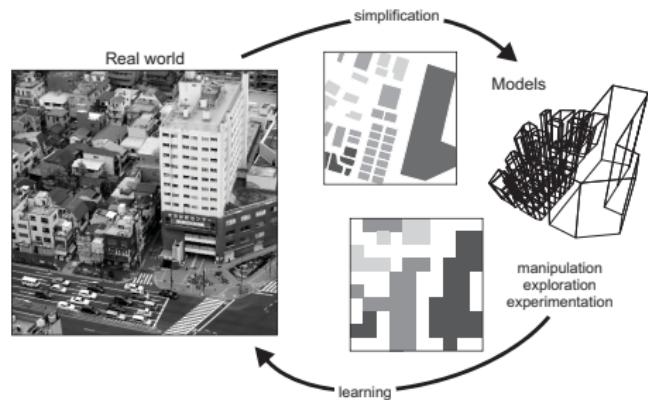


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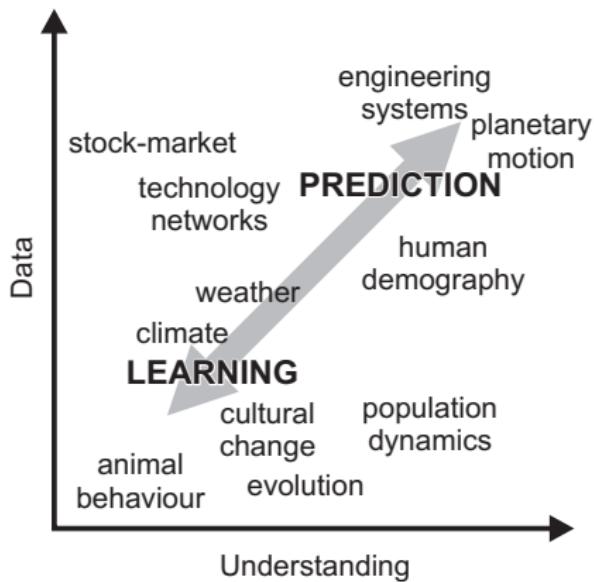
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- Why build models?
- Pattern, process, scale
- Three classes of 'building-block' models
- Representing time and space
- Uncertainty in models
- Example model weaving it all together



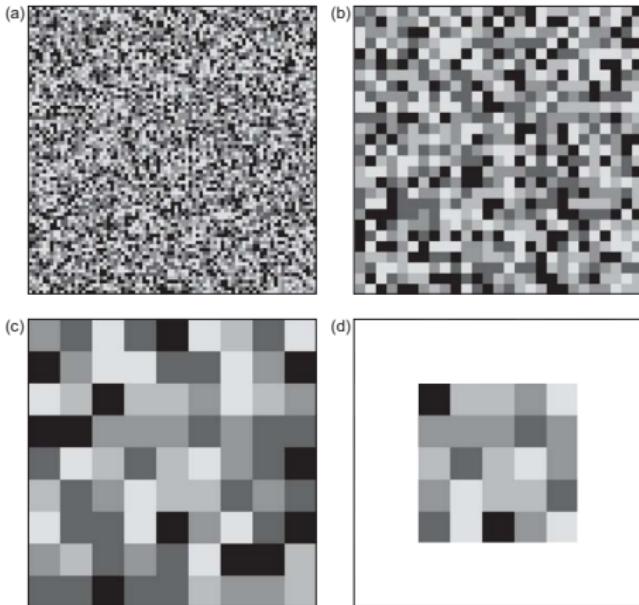
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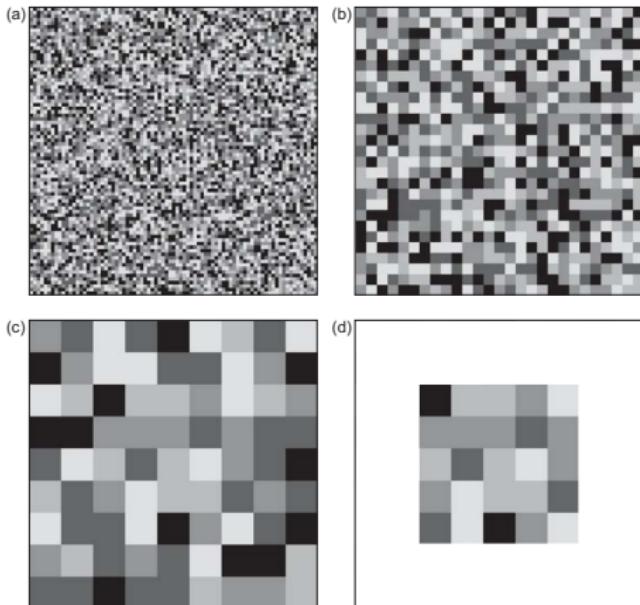
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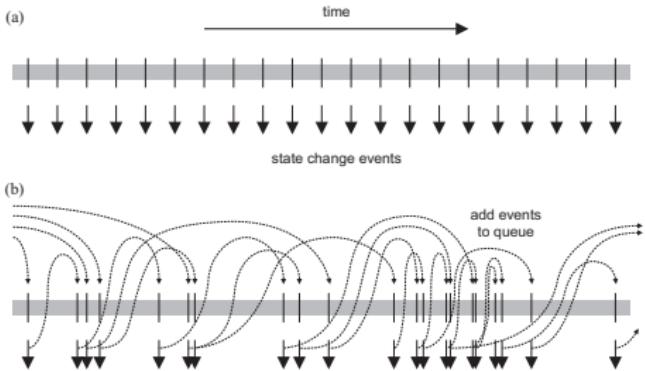
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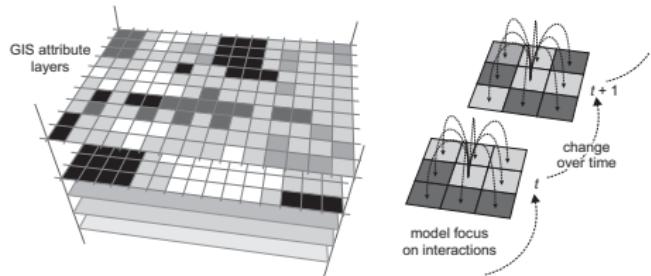
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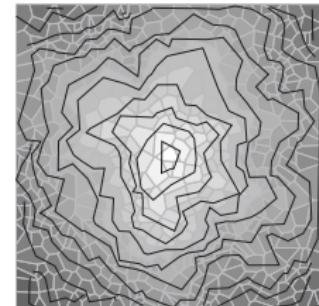
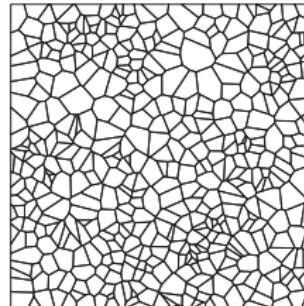
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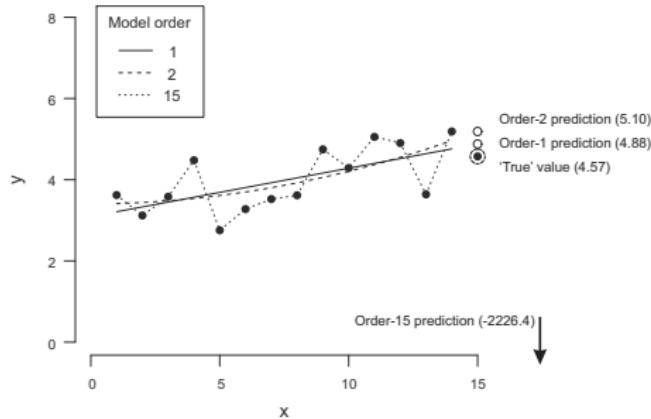
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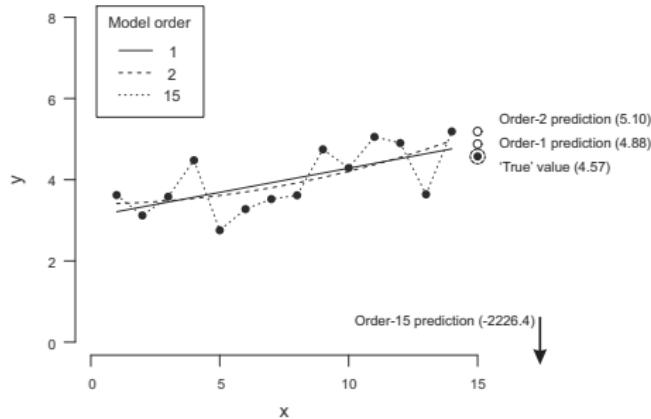
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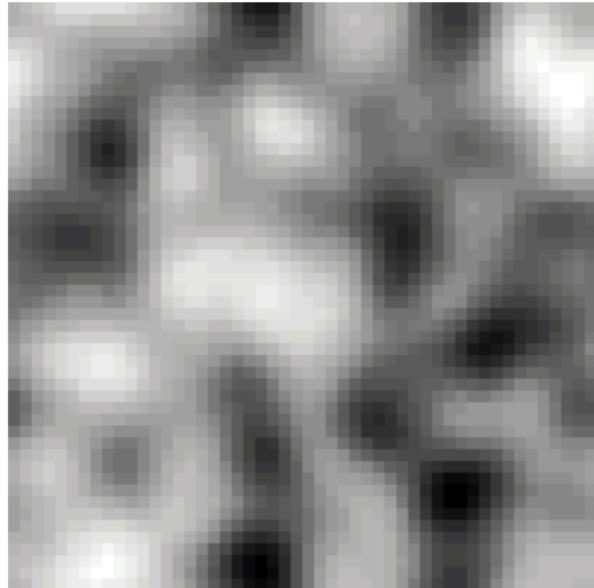
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- Localised averaging
- Majority rule
- Contact process
- Competing contact processes
- Succession
- Rock-scissors-paper
- Voter model
- Schelling model



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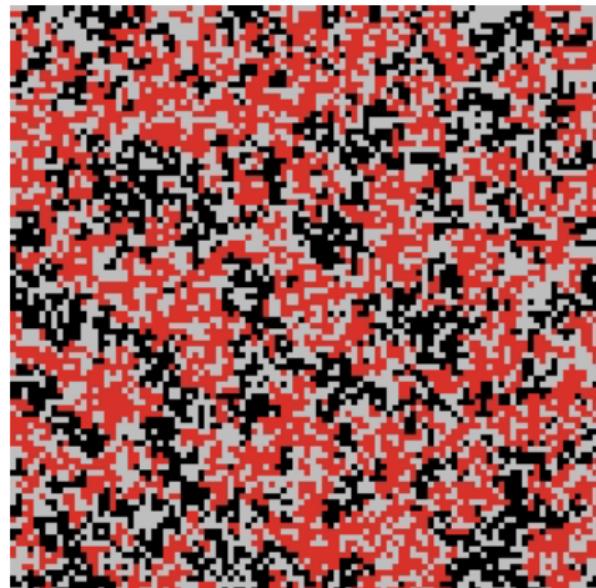
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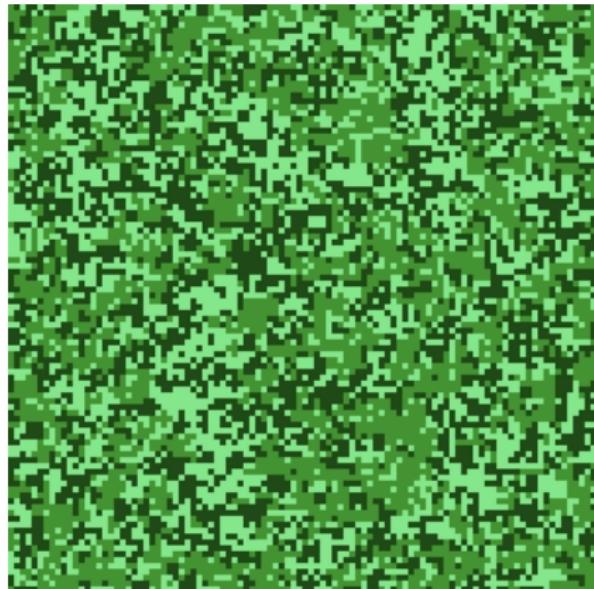
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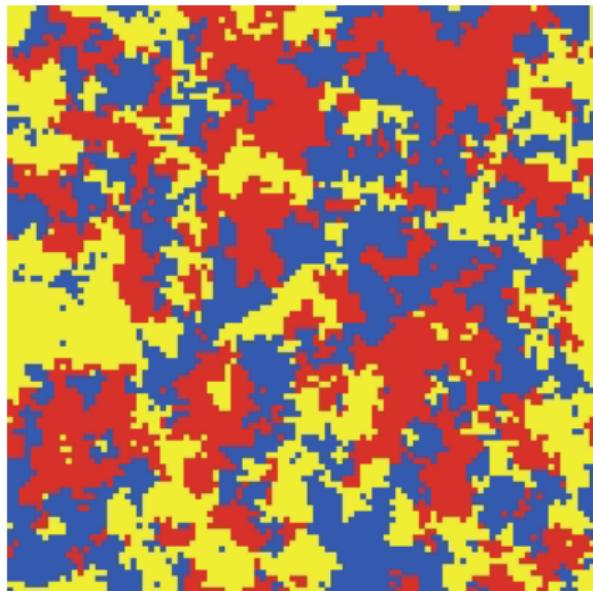
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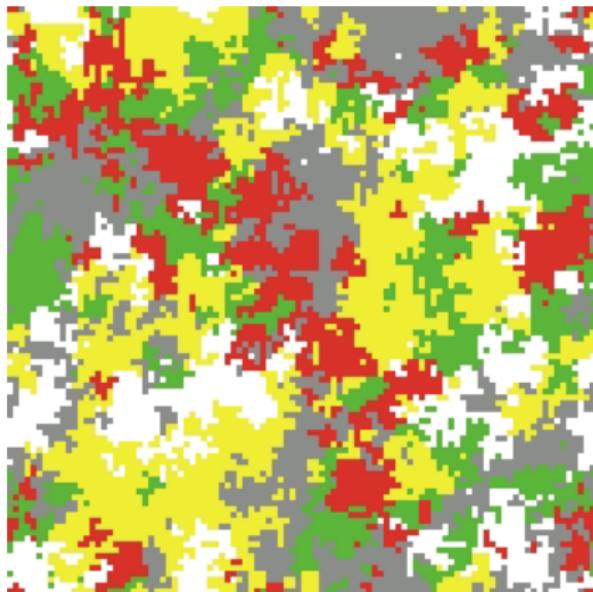
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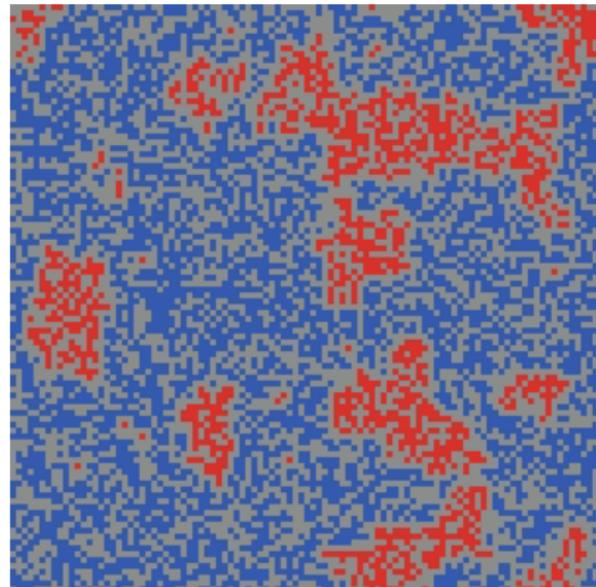
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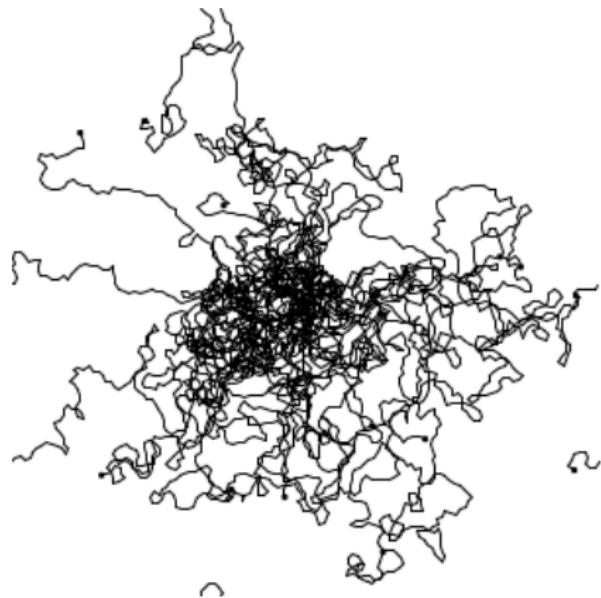
- Random walk

- Correlated random walk
- Lévy walk (heavy-tailed step lengths)
- Searching or foraging
- Search in a resource landscape
- Flocking



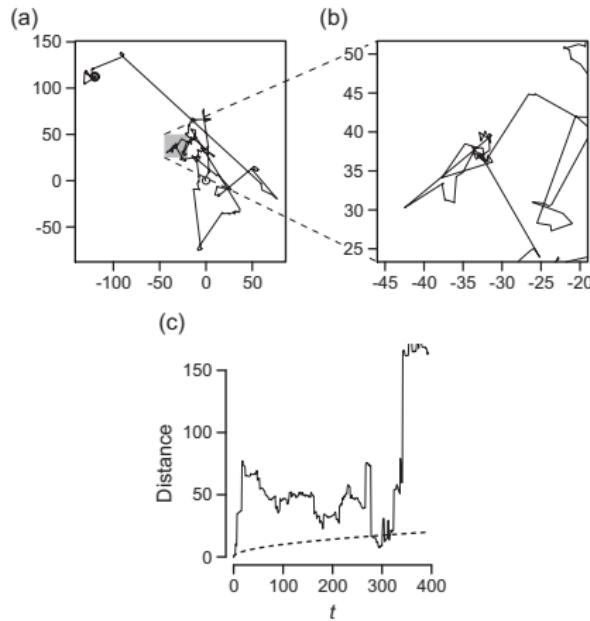
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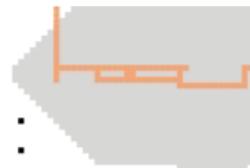
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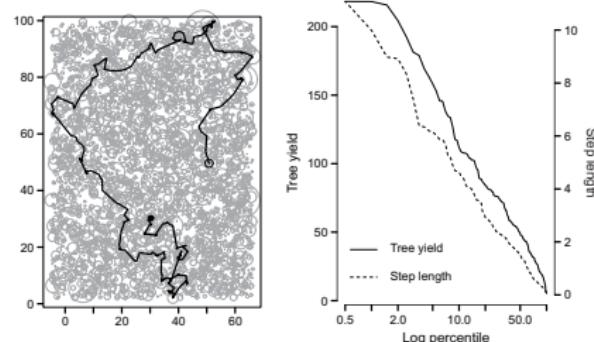
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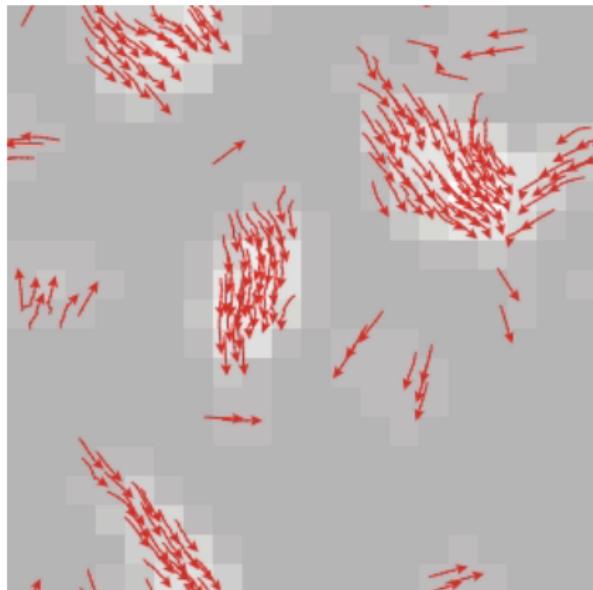
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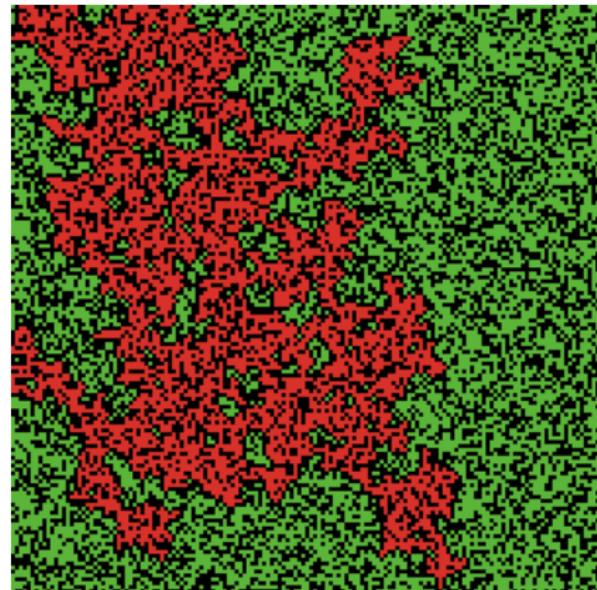
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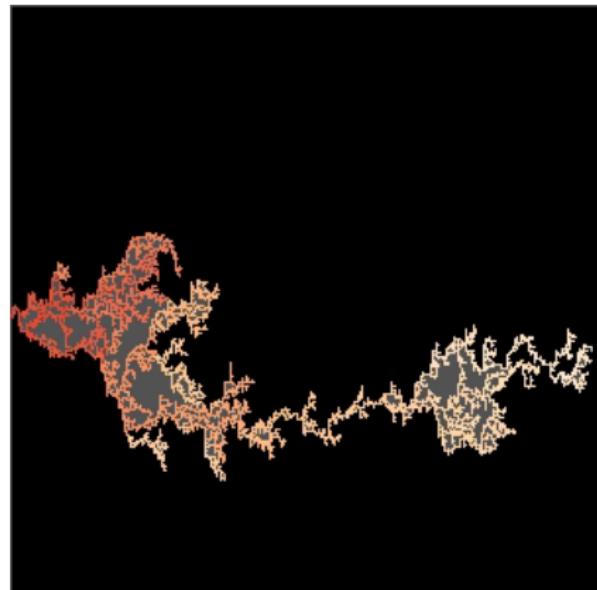
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- Percolation, e.g. fire
- Invasion percolation
- Eden growth
- Modified Eden growth with noise reduction
- Diffusion-limited aggregation



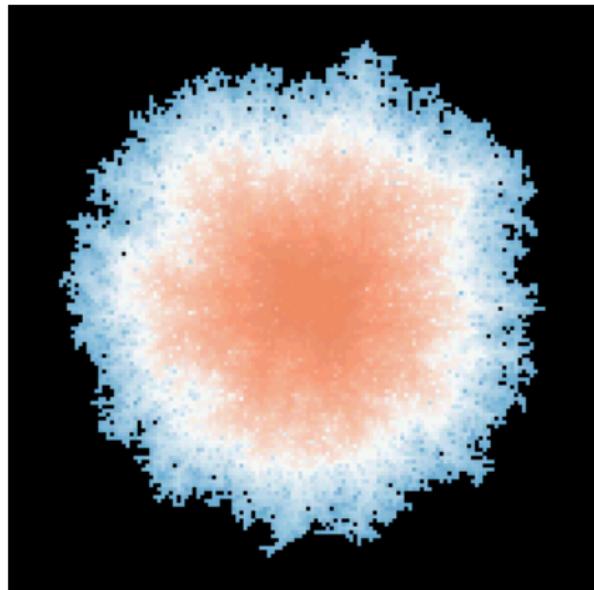
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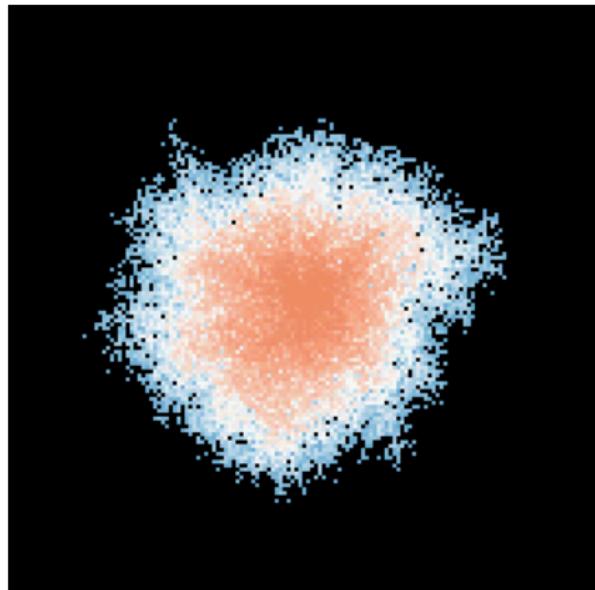
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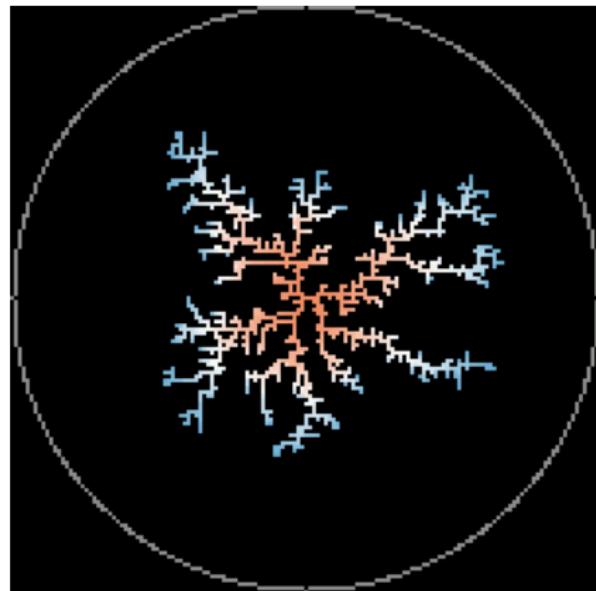
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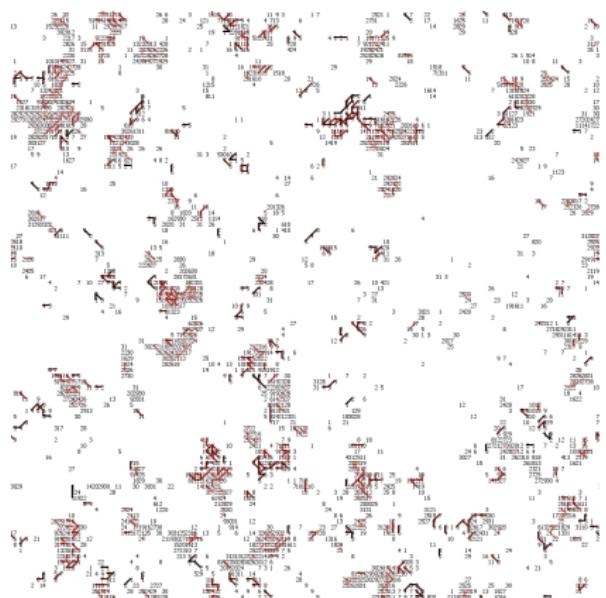
- Predator on a pest-free island: random walk + voter model patchy landscape
- Model of gentrification as interacting succession processes (with Cheng Liu)
- Models of aboriginal (Australian) use of landscape (with Simon Holdaway, Ben Davies, Tom Brughmans, Iza Romanowska)

```
;; random walk
to step
  move-to one-of neighbors4
end

;; voter model
to create-world
repeat n [
  ask patches [
    set state [state] of one-of neighbors4
  ]
]
end
```

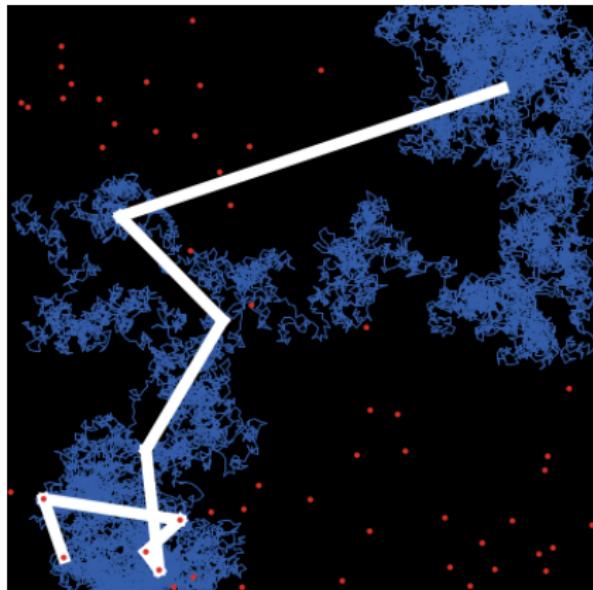
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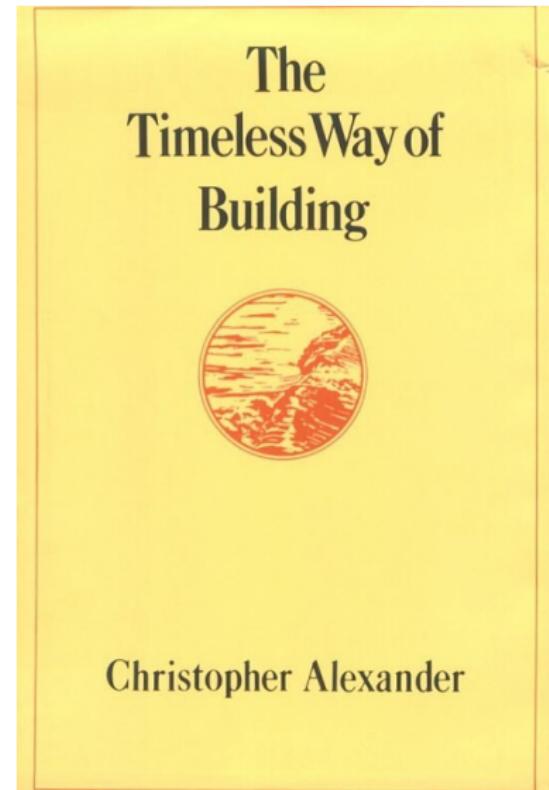
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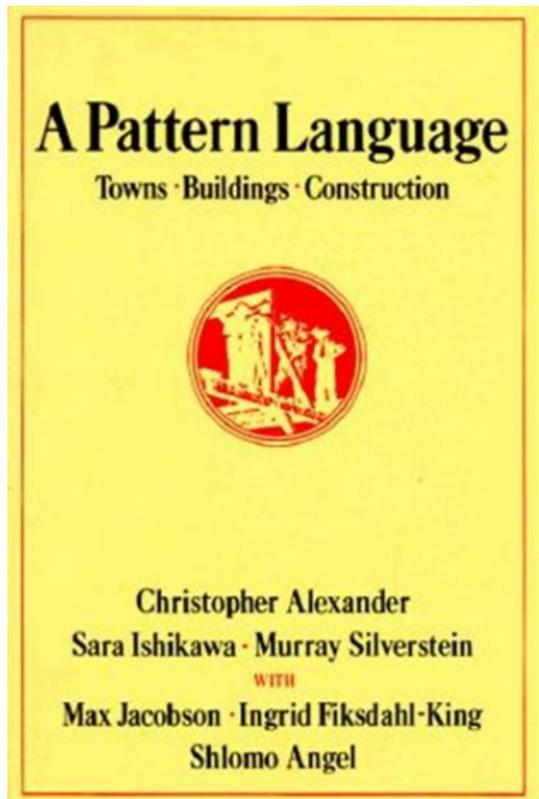
# Christopher Alexander's pattern language

Alexander's concept of a pattern language is presented in *The Timeless Way of Building* (1979)

- Patterns of events *every place is given its character by certain patterns of events that keep on happening there* (p 54)
- Patterns of space *These . . . are always interlocked with certain geometric patterns in the space* (p 75)
- A pattern language *is a system which allows its users to create an infinite variety of . . . buildings, gardens, towns* (p 186)
- The structure of the language *is created by the network of connections among individual patterns* (p 305)



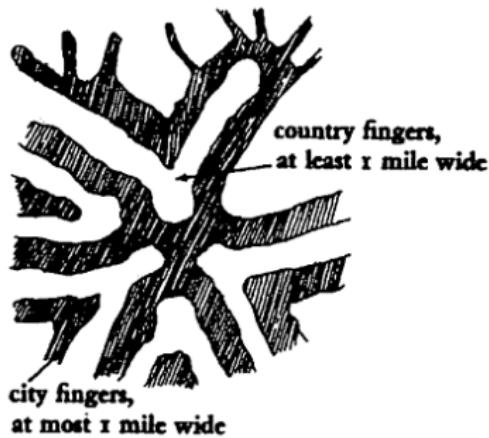
# Alexander's pattern language



Before spelling out the underlying theory Alexander with others, presented a language of 253 patterns in *A Pattern Language* (1977). These design patterns each describe *a problem... and the core of the solution to that problem* (p x) For example:

- City country fingers (p 25)
- Light on two sides of every room (p 749)
- Old people everywhere

# Alexander's pattern language



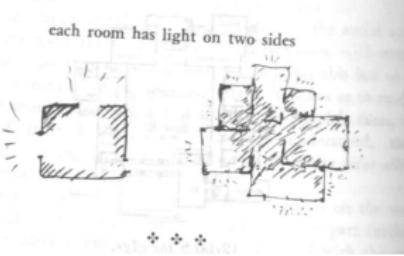
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# Alexander's pattern language

Locate each room so that it has outdoor space outside it on at least two sides, and then place windows in these outer walls so that natural light falls into every room from more than one direction.

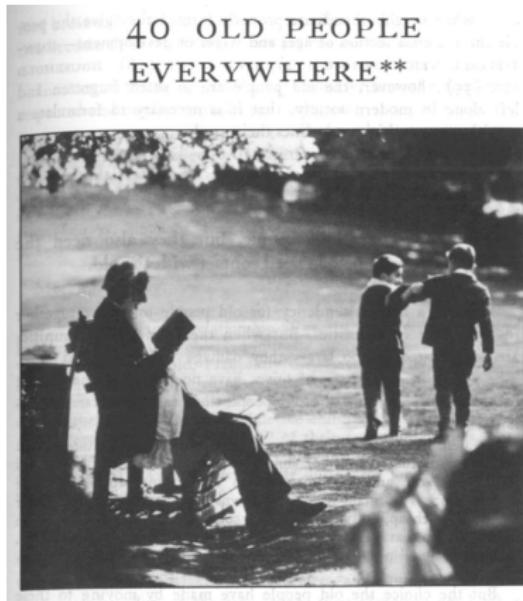
each room has light on two sides



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# Patterns in computer science

- Alexander's notion has successfully translated across to software engineering
- Formalisation of what a pattern is, remains elusive
- The early focus tended to be on individual patterns
- Some more recent work has shifted the focus to languages

From the present perspective, like Alexander's original formulation, the emphasis on design problems may not be entirely appropriate

# From building-block models to patterns

- Our building-block models are (spatial) pattern focused
- 'Pattern' approach requires a multi-aspect, multi-scalar perspective
- For example, a *mobile entity* pattern might also require . . .

... the associated pattern

- . . . and together these could compose a language

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→ This is the first step in moving from building-block models to patterns

- ...and together these could compose a language

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Behavioural patterns to the class 'Shuttle' may be something like:

- ... choose a target
- ... move towards target
- ... or Statistical patterns to choose a distance/direction
- ... and Spatial context patterns
- ... and together these could compose a language

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http://www.judithprestwich.com/patterns.html

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    - *Network* (planar, spatial, non-spatial)
    - *Regular lattice*
    - *Toroidally-wrapped space*
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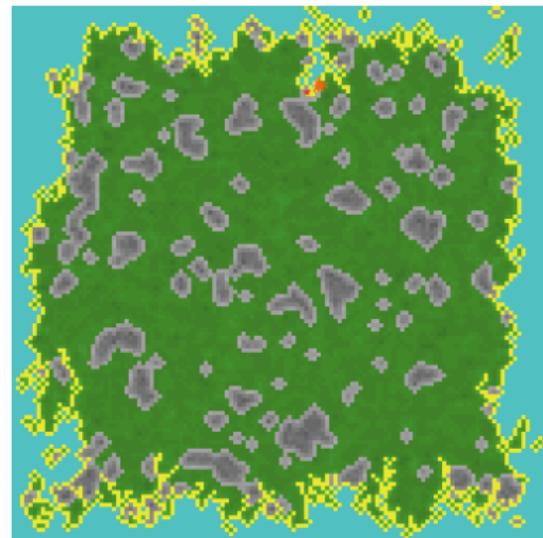
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- High value resources *percolation patches*
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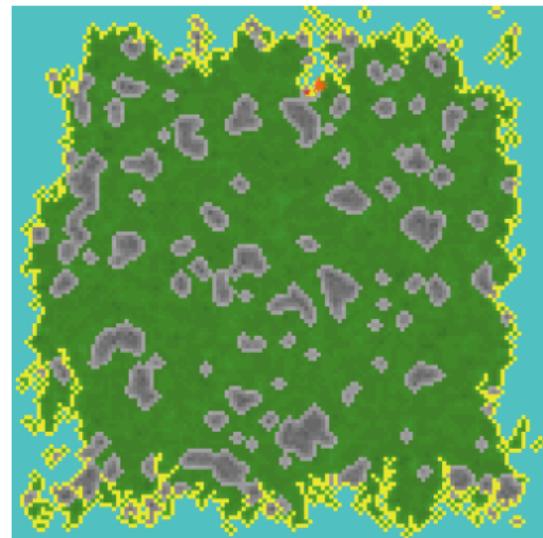
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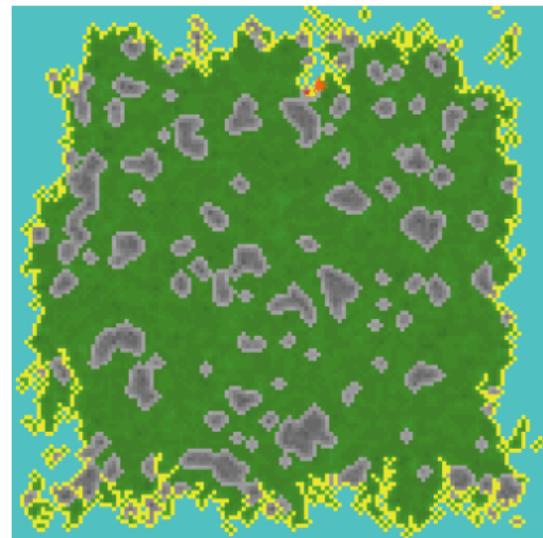
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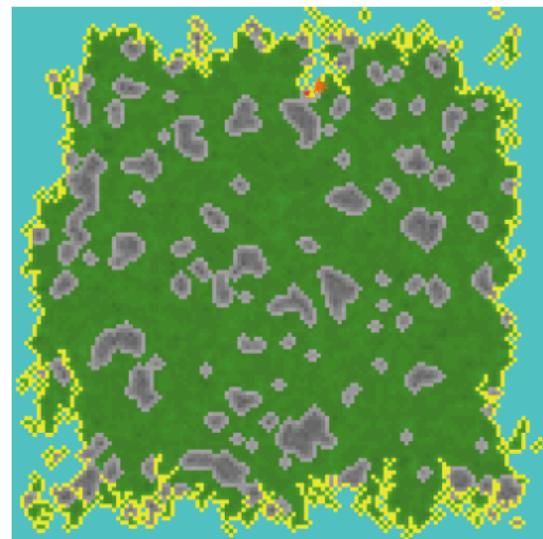
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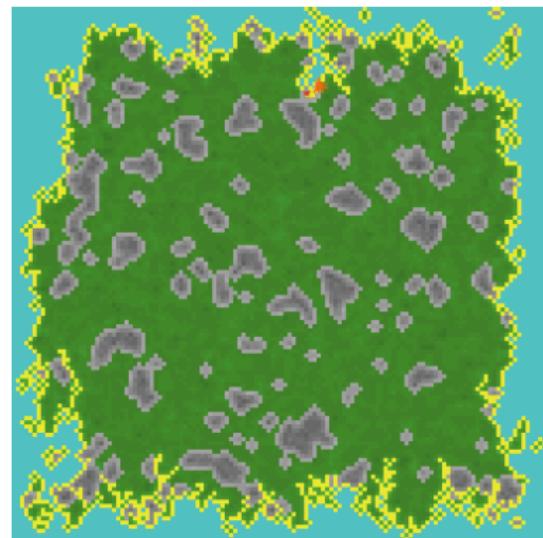
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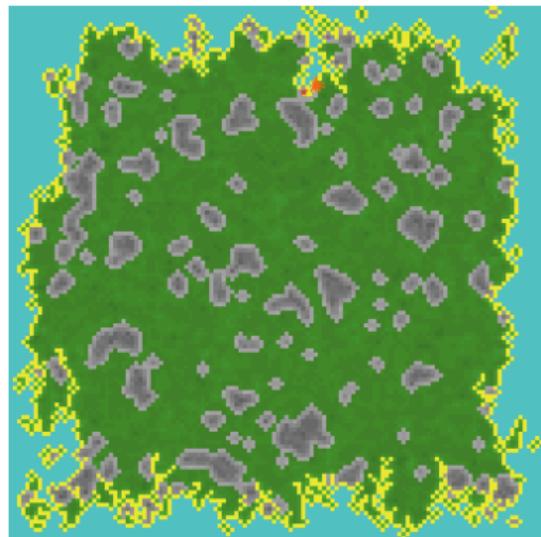
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# Acknowledgments

- Questions?
- Comments?

See <http://patternandprocess.org>

