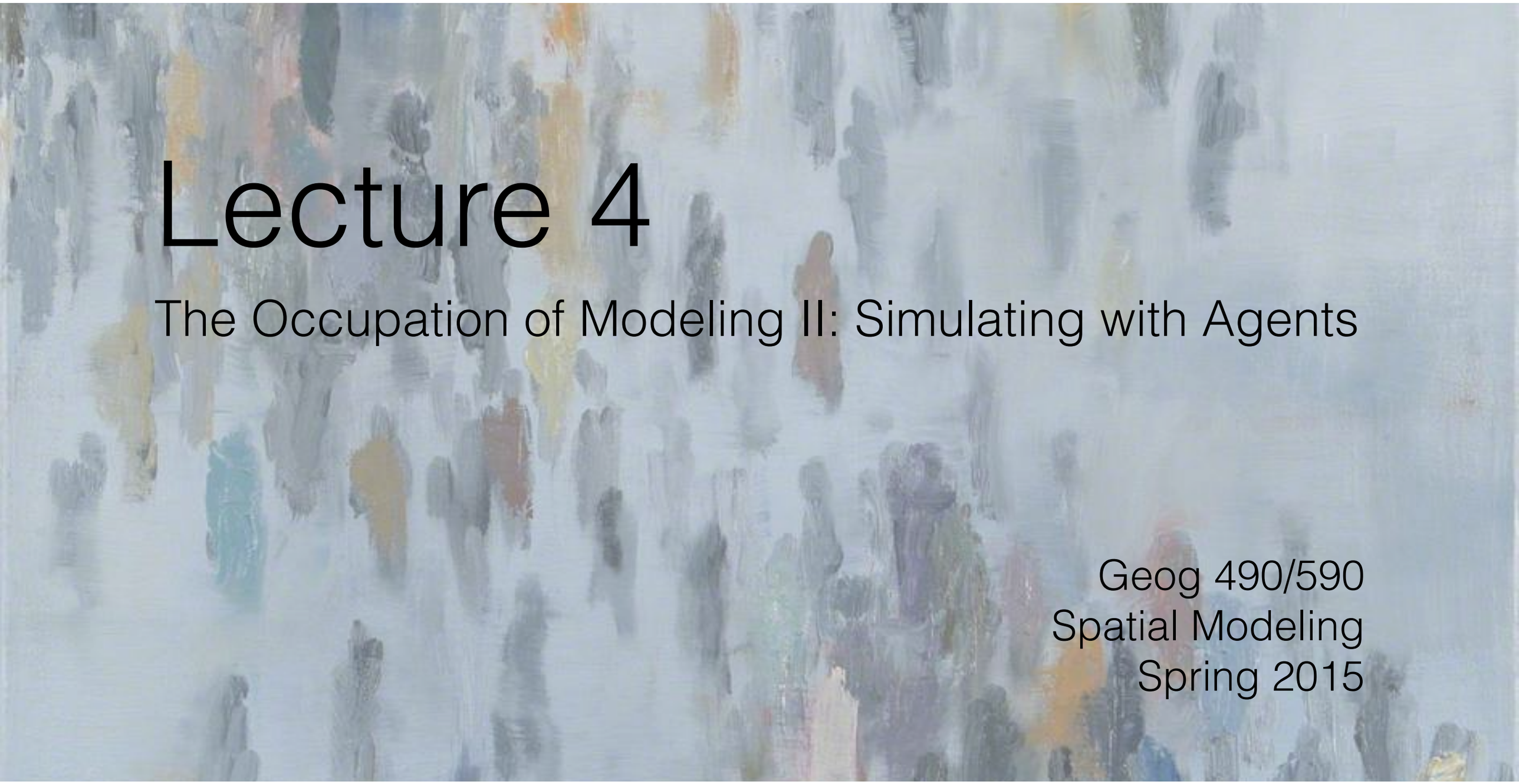


Lecture 4

The Occupation of Modeling II: Simulating with Agents

Geog 490/590
Spatial Modeling
Spring 2015

agent-based models

Models that represent a system's individual components and behaviors.

Agents are autonomous, self-interested entities that interact with each other and their environment locally.

ABMs are used to simulate complex systems where simple individual (and often self-interested) behaviors lead to unpredictable, non-linear and complex patterns.

Agents:

are unique: differ in size, location, resource reserves, and history

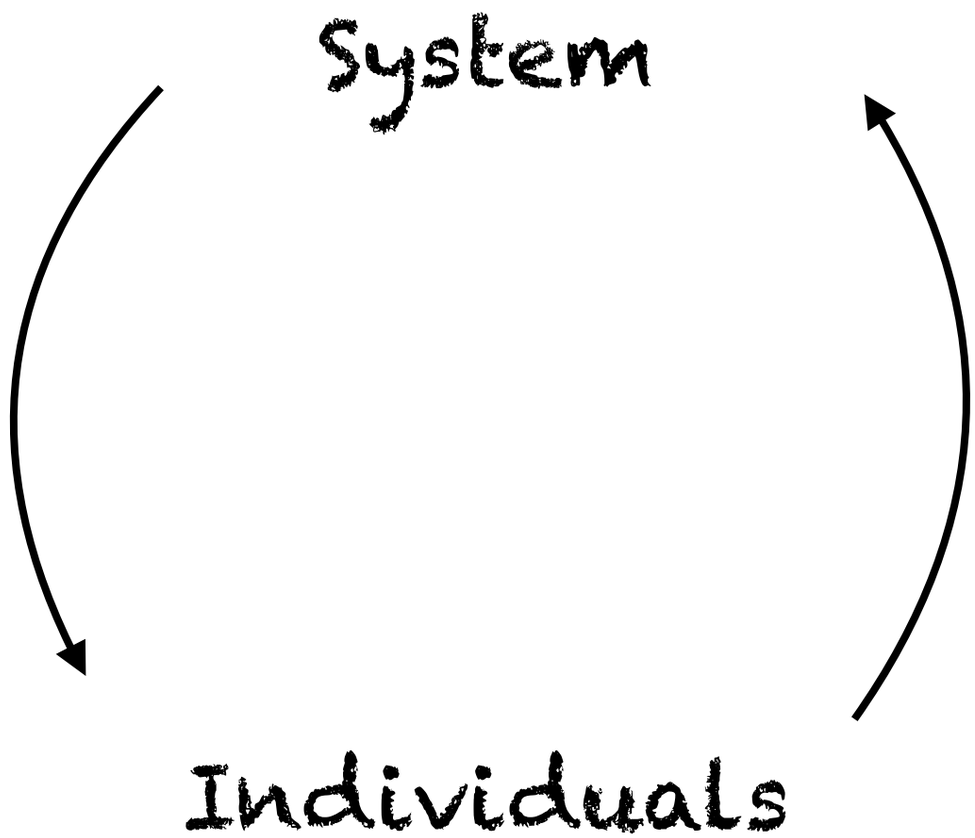
interact locally: typically act based on information from neighborhood

are autonomous: act independently of each other to achieve one's own objectives or goals

are adaptive: adjust behavior based on their current state, the state of their neighbors, and the state of their local environment

These individual characteristics lead to emergent patterns over time.

Multi-scale



Other forms of random walks

lazy walks

reinforced walks

self-avoiding walks

examples?

moving with purpose

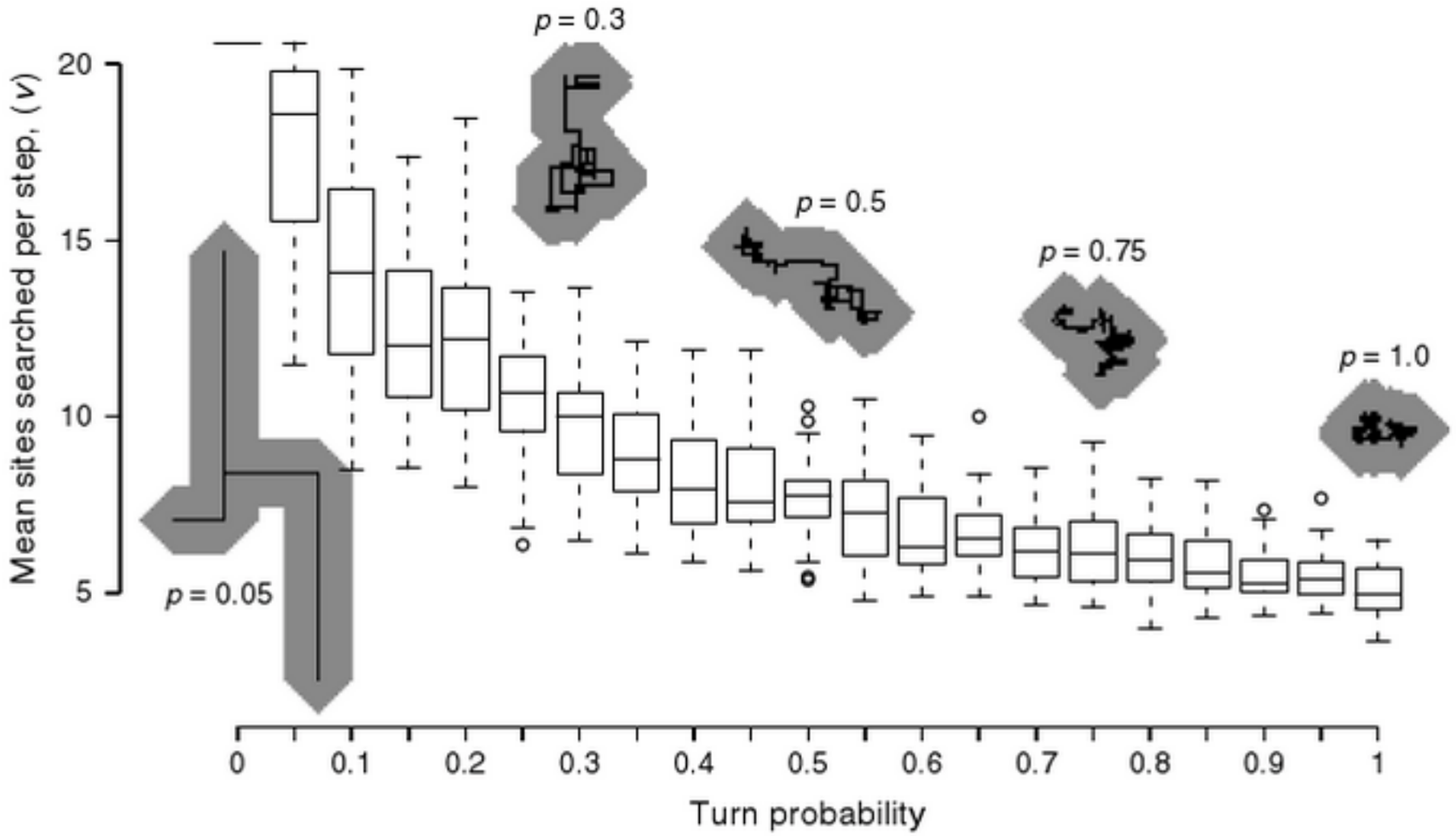
foraging

Foraging represents the behavior of an agent search for something in the landscape.

An agent will move from one cell to the next until it finds a resource that it is looking for.

One the agent obtains the resource, it receives a reward while subsequently depleting the resource at that location.

The resource typically replenishes if no agent is currently at that location.


p = 0.3
p = 0.5
p = 0.75
p = 1.0
p = 0.05
Mean sites searched per step, (V)
20
15
10
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Turn probability

Foraging Agent Techniques

Path memory: agent avoids locations visited previously and found to have no resources, or revisits locations where resources where previously found.

Mental maps: agent constructs a mental map of landscape that records the richness of resources at each location visited and the time when those resources were obtained. Efficient paths to rich resource locations can also be recorded.

flocking

Flocking is an emergent property resulting from individual behaviors focused on imitation, attraction or repulsion.

Reynolds (1987) Flocking Model:

Repulsion: don’t get too close to other agents.

Attraction: stay within a range of neighbors.

Imitation: match speed and direction of neighbors.

$$\theta(t+1) = \langle \theta(t) \rangle_r + \Delta\theta$$

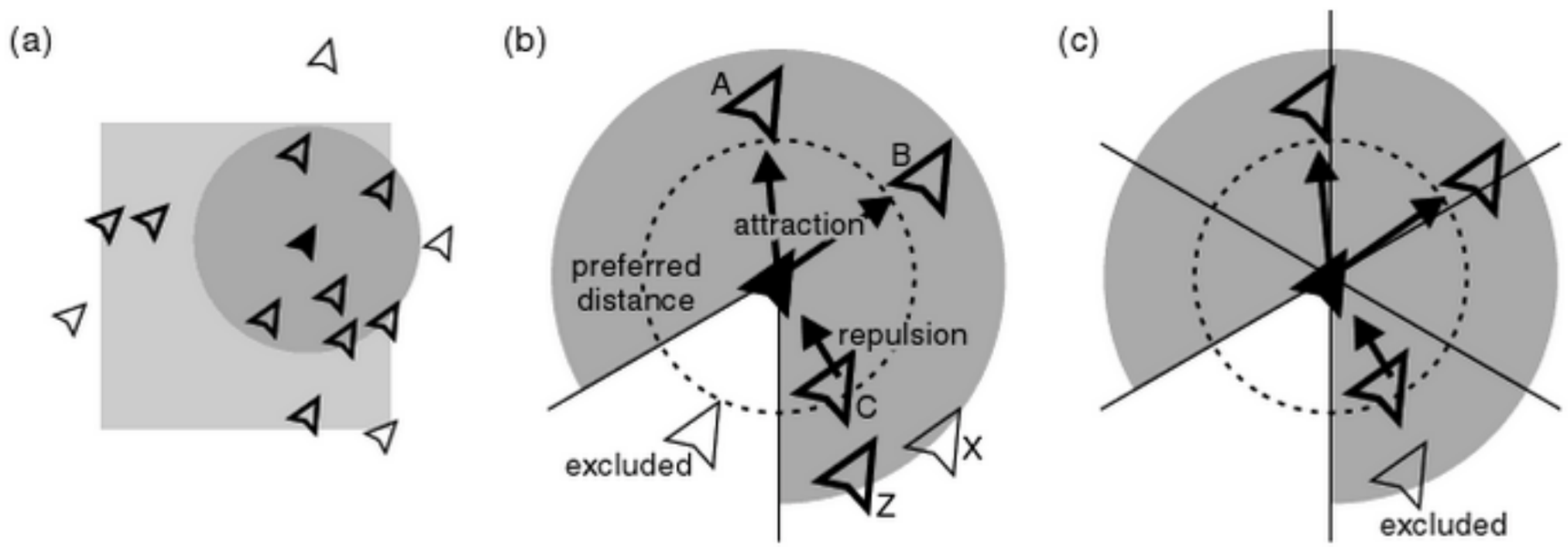


Figure 4.17 Details of the selection of flock-mates and the body-force. (a) Alternative definitions of flock-mates, one based on square cells in a lattice, which may include many more mates (heavy outlines) than those included by a circular radius. (b) Exclusion of some flock-mates by a cone angle restriction, and the attraction and repulsion effects associated with a preferred distance setting. (c) Exclusion of a second order mate by a 'pie slice' criterion. See text for details.

so why model?

to predict?

- explain (not predict)
- guide data collection
- illuminate core dynamics
- suggest dynamical analogies
- discover new questions
- promote a scientific habit of mind
- bracket plausible range of outcomes
- illuminate uncertainties
- offer crisis options in near-real time
- demonstrate trade-offs
- challenge prevailing theories
- expose conflict between knowledge and data
- train practitioners
- discipline policy dialogue
- reveal the simple to be complex

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