Agent-based modeling

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Defining a complex system

- Generally associated to social and biological systems (actively seeking connections).
- Strong interactions, so that current events heavily influence the probability of future events
- Characteristics
  - Multiple agents and environment: location, attributes (heterogeneous), success measure, interaction patterns
  - Agent strategies (heuristics: sensing, processing and acting): adaptation and evolution (trial and error through learning, survival)
  - Co-evolution and path-dependence: time and space matter
  - Emergent patterns: decentralized coherence arising from change
  - Difficulty to predict: handling uncertainty, lever points
- Difference with complicated systems

Kinds of questions

- Correlation, description, and explanation
- Standing ovation (social contagion)
  - Magnitude (fn of quality and thresholds) v. dynamics (e.g., waves, fn of location and view, differential influence)
  - Implications for design (policy)
- Beehive (the coordination effect of heterogeneity)
  - Temperature stability (negative feedback)
  - Attack (positive feedback)
- Influence of social and environmental processes on settlement patterns
  - “Failing” can be good

Challenges with ABM

- Messy:
  - Making the right simplifications: problem and questions (purpose)
  - Verification
  - Sensitivity analysis: targeted
  - Documentation
- Difficult to validate:
  - Conceptual: theory and purpose
  - Empirical: qualitative and quantitative matching
- Uncertain:
  - Direction for empirical research
  - Optimality v. robustness (numbers v. insight)
  - Scenarios and plausibility
  - Model ensembles

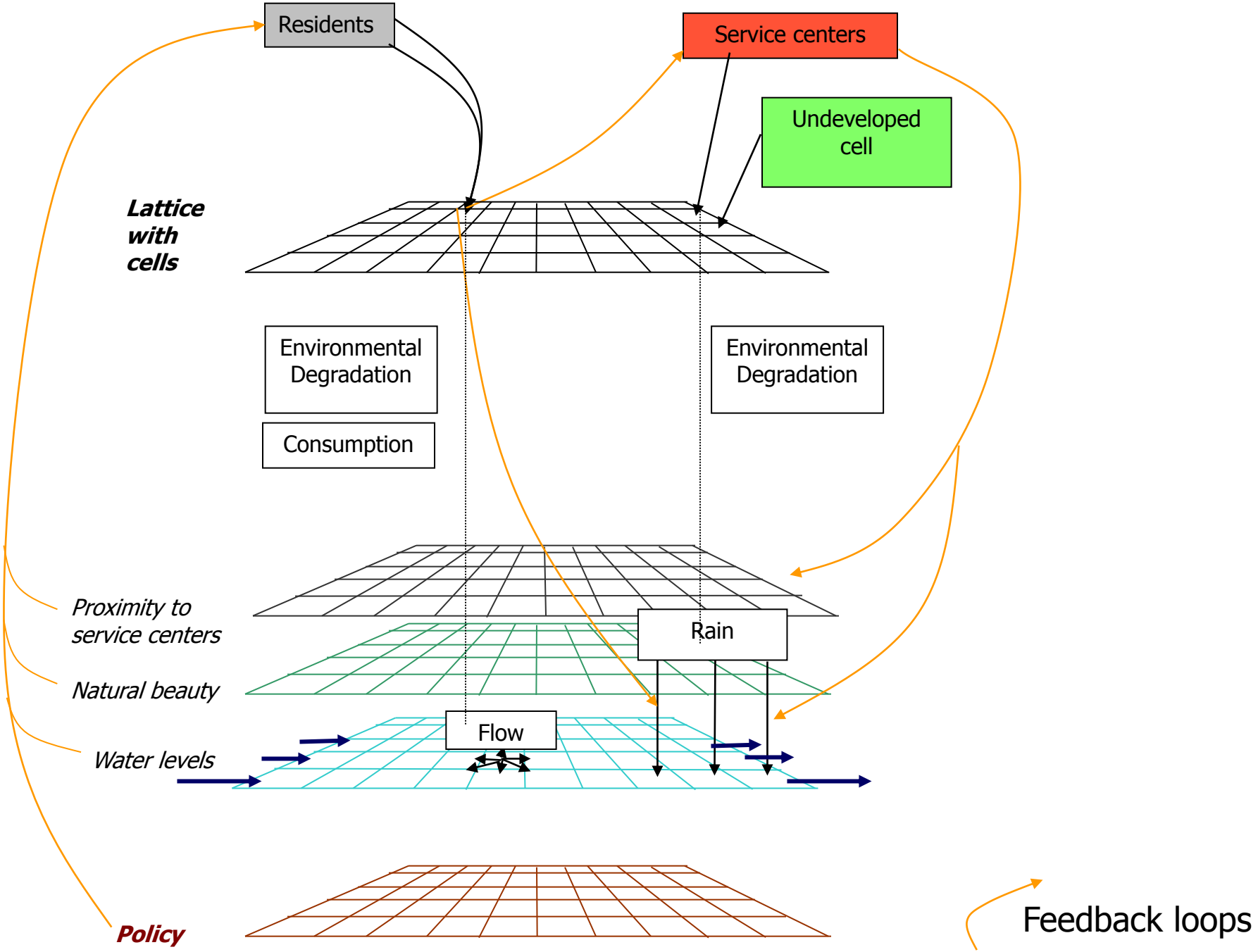
Uses of ABM

- Understanding: relating observations to processes
  - Bridge between disciplines
  - Bridge between science and policy (participatory modeling)
- Theory development: discovery and formalization
  - Explicitness and precision
- Prediction…?

Thursday

The emergence of urban patterns and their social and environmental impacts

- Conceptualization:
  - Problem, questions, actors, environment, interaction, parameters and scenarios, social and environmental metrics.
  - Integrating different disciplines: sources of data (empirical, expert knowledge, scenarios/questions)


Residents
Service centers
Undeveloped cell
Lattice with cells
Environmental Degradation
Environmental Degradation
Consumption
Proximity to service centers
Natural beauty
Water levels
Rain
Flow
Policy
Feedback loops

SOME-GW (only interface): Conceptualization and representation

- Utility functions
  - Form
  - Factors and weights
  - Normalization
- Strategies
  - Optimizing
  - Satisficing
  - Other possibilities: Service centers, elimination by aspects
- Environmental processes
  - Degradation of natural beauty
  - Groundwater flow: Darcy's Law
- Evaluation of outputs (multiple perspectives)
  - Using different "currencies"

Ethics and values

- Participatory modeling: conceptual validation and collective learning and innovation (URISA)
- Actors and preferences
- Policy scenarios