

# From Pixels to Skylines: Atlanta Urban Growth Modeling and Simulation

Tingyu Liu, Jayda Ritchie, DaMarcus Patterson, Zhangding Liu  
School of Computational Science and Engineering  
Georgia Institute of Technology

## Introduction

Atlanta is experiencing significant urban growth, which presents challenges such as traffic congestion, air pollution, and loss of forest and agricultural lands. Urban growth prediction model and simulator help stakeholders understand and address the challenges, ensuring a sustainable future for Atlanta.

## Objective and Method

Our study analyzed land use patterns as cell states and developed a Cellular Automata model with Moore neighbors. Major innovations is the distinct transition rules for different urban development intensities.

### Cell States



Figure 1. States of urban development intensity example

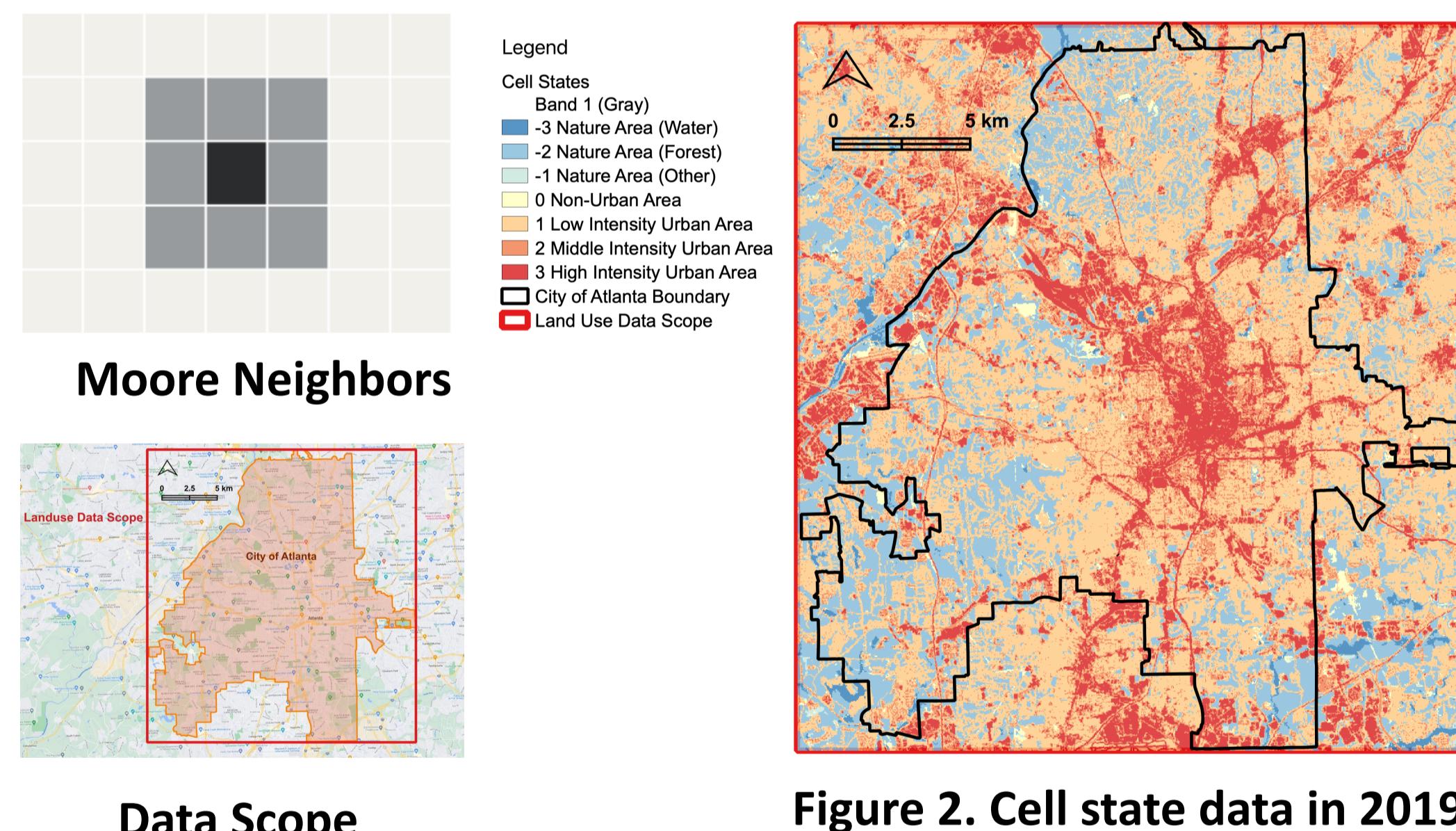


Figure 2. Cell state data in 2019, re-classified from land use

### Transition Rules

1. Urbanization Rule 1: non-urban(0) cell  $\rightarrow$  low-intensity urban (1) if at least 5 of its neighbors are in state 1.
2. Urbanization Rule 2: low-intensity urban (1) cell  $\rightarrow$  medium-intensity urban (2) if at least 5 neighbors are in state 2, or 4 neighbors in state 3.
3. Urbanization Rule 3: medium-intensity urban (2)  $\rightarrow$  high-intensity urban (3) state if at least 5 of its neighboring cells are in state 3.
4. Environmental Rule: non-urban(0) cell will not transition to urban state(1-3) if at least 3 of its neighbors are water(-3) or vegetation(-2).
5. Forest Conservation Rule: non-urban (0) state will not transition to any urban state if it has a nature-forest (-2) cell neighbor.

## Simulator and Hyper parameter Adjustment

We implement CA simulator based on transition rules and conduct hyper parameter adjustment with 150 trails. Current parameters in transition rules are the best in accuracy based on two validation indicators, Overall Accuracy (OA) and Figure of Merit (FOM). We identified that Rule 2 (Low Intensity Urban to Medium Intensity Urban transition rule) plays a crucial role in the urban growth patterns.

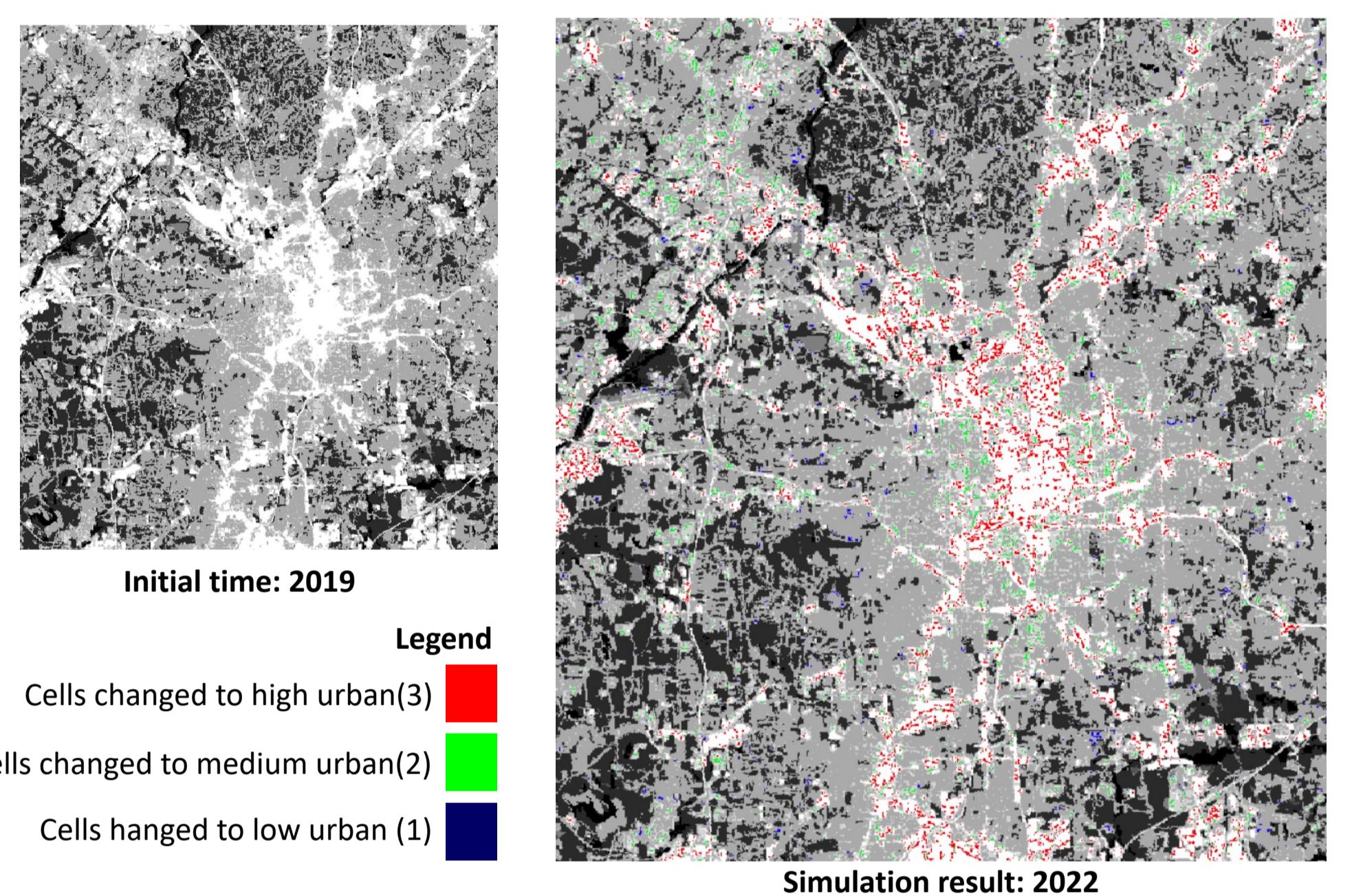


Figure 3. Simulation Result

