

Cellular Automaton Simulation of Open-Field Foraging with Area-Restricted Search

by

Anthony Artino

Research Project

Submitted in fulfillment of the requirements for the Modeling Projects Seminar Course (MATH 42039), under the supervision of Prof. Jing Li, as part of the Experiential Learning and Writing Intensive Course components.

Kent State University

April 21, 2025

Phase 1: Initial Random Walk Search

Key Formulas and Rules:

- If food is not found:

$$V_{t+1}(i, j) = 0$$

- If food is found:

$$V_{t+1}(i, j) = 1$$

- Diffusion using 4-neighbor (Von Neumann) model:

$$V_{t+\Delta t}(i, j) = (1 - 4r) \cdot V_t(i, j) + r \cdot \sum_{k=1}^4 V_{kt}$$

- Diffusion rate:

$$0 < r < 0.25 \quad (\text{e.g., } r = 0.05)$$

Phase 2: Diffusion Without Animal (Memory Consolidation)

Key Process:

- Continued diffusion for 30 time steps:

$$V_{t+1}(i, j) = (1 - 4r) \cdot V_t(i, j) + r \cdot \sum_{k=1}^4 V_{kt}$$

Phase 3: Return and Area-Restricted Erratic Search

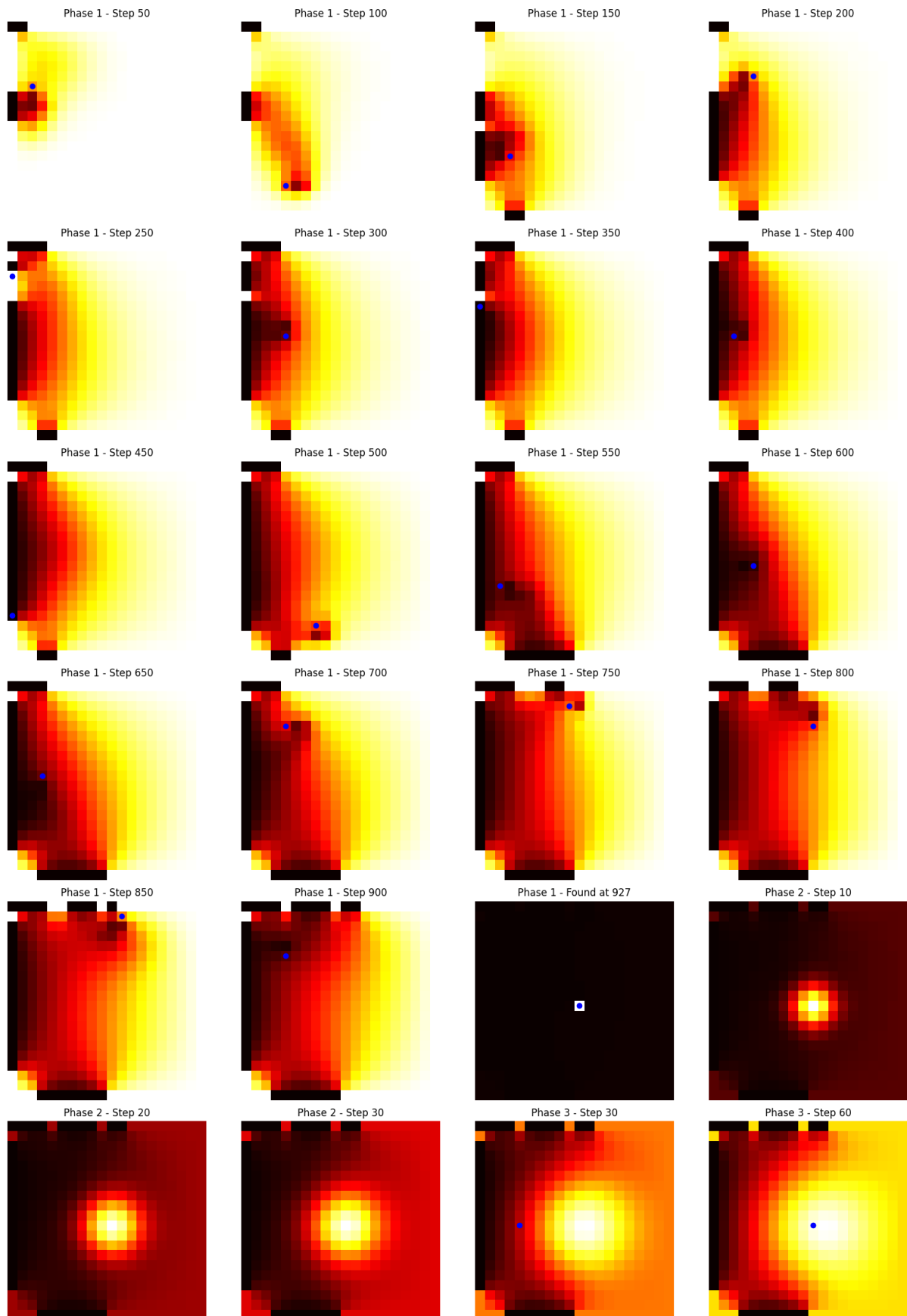
Key Process:

- Memory-guided diffusion continues:

$$V_{t+1}(i, j) = (1 - 4r) \cdot V_t(i, j) + r \cdot \sum_{k=1}^4 V_{kt}$$

- Search is biased toward regions with higher $V(i, j)$

Simulation of Area-Restricted Search Following Food Discovery



Distance Plot of Phase 3

