Toy model documentation

Script: toymodel.r

This document describes the equations used in each function, in order.

0. start with the transition probability matrix

$$P = \begin{bmatrix} 1.00 & 0.00 & 0.00 & 0.00 \\ 0.00 & 0.95 & 0.01 & 0.04 \\ 0.00 & 0.01 & 0.99 & 0.00 \\ 0.00 & 0.09 & 0.01 & 0.95 \end{bmatrix}$$

1. call step_forest()

2. calls neighbor_frac(r, s)

calculates the fraction of neigboring cells (# neighbors n) in a given state s.

$$s_f = \frac{\sum_i^n \mathbb{K}(r_i = s)}{\sum_i^n 1}$$

3. calls modify_P(P, u_frac, g_frac, f_frac, r_frac)

Spatial Modification Logic: The transition matrix P is updated at each cell based on the surrounding neighborhood fractions (f). The modified probabilities P' are calculated as follows:

Undisturbed Transitions ($i = 1$):
$$P'_{12} = P_{12} + 0.3 f_g + 0.2 f_f$$
$$P'_{13} = P_{13} + 0.8 f_f$$

Recovery Transitions ($i = 2, 3$):
$$P'_{24} = P_{24} + 0.1 f_u$$
$$P'_{34} = P_{34} + 0.1 f_u$$

Normalization: To ensure each row i sums to 1, the final probability π_{ij} is:

$$\pi_{ij} = \frac{P'_{ij}}{\sum_{k=1}^4 P'_{ik}}$$