**Model description**

This model is a reimplementation of a model published by DiNuzzo & Griffin (2020, Proc. R. Soc. B 287: 20201095.). Its purpose is to determine how fast populations that differ in their make-up of active and inactive individuals reach an ideal and free distribution across patches of different resource abundance, such that the intake rate of all individuals is optimized.

Variables and scales

Individuals are defined by their currently held location (the patch that they are on) and their activity level, which describes the rate, at which individuals scan the environment and subsequently move to the patch with the highest possible intake rate. Individuals are ideal and free in the sense that they can accurately assess all patches and move to whichever provides the highest potential intake rate. We distinguish between active individuals with an activity level a >= 0.5, and inactive individuals with an activity level 1 – a. Active and inactive individuals occur at proportions between 0 and 1 and together make up the total population of size N.

The landscape consists of an array of patches of size D. Each patch holds a random resource value between 0.5 and 1, thus assuming that individuals occur in an area that is at least somewhat suitable in all locations. The intake rate is calculated in accordance with an immediate consumption model with continuous input (see e.g. Van der Meer & Ens 1997): The Individual intake rate on a patch is given by the amount of resources divided by the number of individuals present. Individuals can accurately assess their current intake rate as well as the potential intake rate across all other patches.

Process overview and scheduling

Movements can be performed at any point in time. We use the Gillespie algorithm to determine when the next event occurs and which individual moves.

The simulation stops when all individuals have optimized their intake rates, or when a maximum of a 100 time units is reached. Each x time unit we check whether the IFD has been reached, and each y time units we record the proportion of optimally distributed individuals and the intake variance of all individuals.

Output

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| --- | --- |
| **Parameter** | **Default values** |
| Population size N | {8, 40, 100, 1000} |
| Number of patches D | 100 |
| Activity level a | 0.8 |
| Proportion of active individuals | {0.00, 0.25, 0.50, 0.75, 1.00} |
| scenes | 300 |
| T\_max scenes | 100 |

Initialization

Individuals are randomly distributed on a landscape constituted by an array of patches. Each patch is initialized with a random resource value between 0.5 and 1, assuming that the individuals inhabit an area that is at least somewhat suitable in all locations. Each individual has an activity level, which defines the rate at which it moves. We use the Gillespie algorithm to determine when the next movement occurs and which individual moves. Individuals have perfect knowledge of the entire landscape and potential intake rates and move to the patch offering the highest intake. After all individuals have optimized their intake rates, the simulation stops. We record the time-to-IFD and the proportion of optimally-distributed individuals each 0.01 time steps.

We explore different population densities (50, 200, 1000) on a 20 by 20 grid, and different values of activity levels in a dimorphic population with a mean of 0.5 (0.1 || 0.9, 0.2 || 0.8, 0.3 || 0.7, 0.4 || 0.6, 0.5|| 0.5). We expect our results to be invariant to landscape size itself, because individuals can move freely between all patches. For the same reason, landscape structure does not influence our results, indeed to think of it as a two-dimensional landscape is only a mental support. We further investigate the influence of different functional responses on the time-to-IFD.