AADIS vector model

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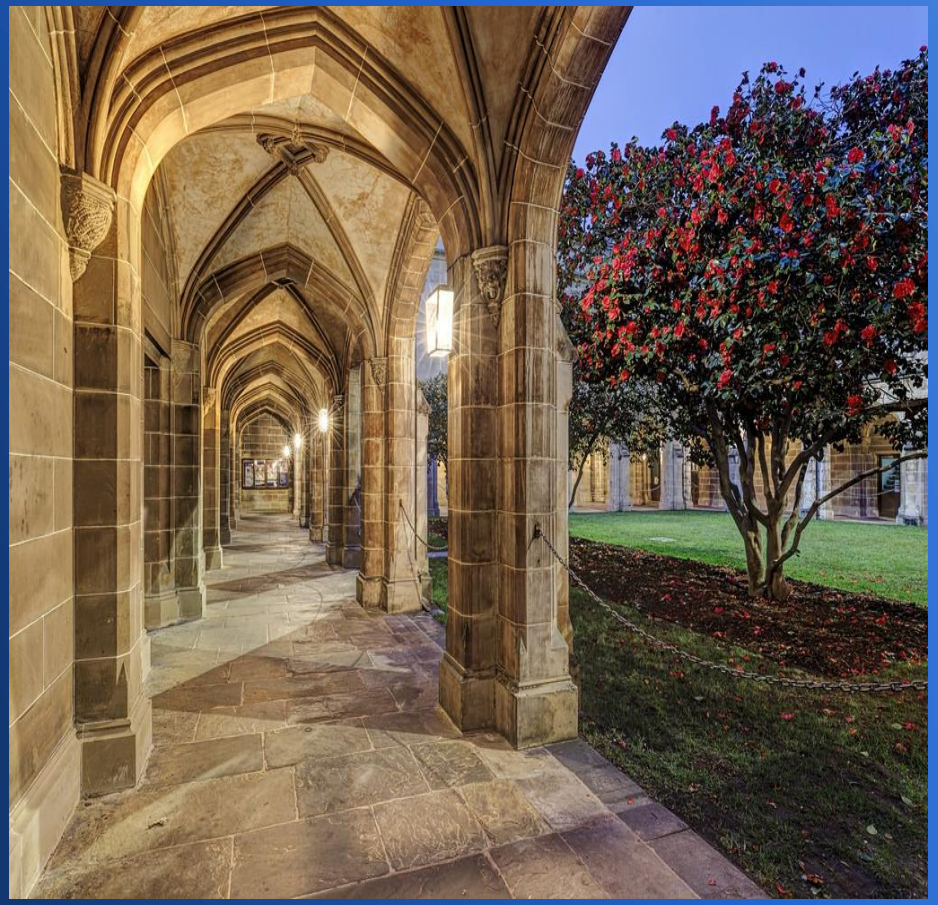


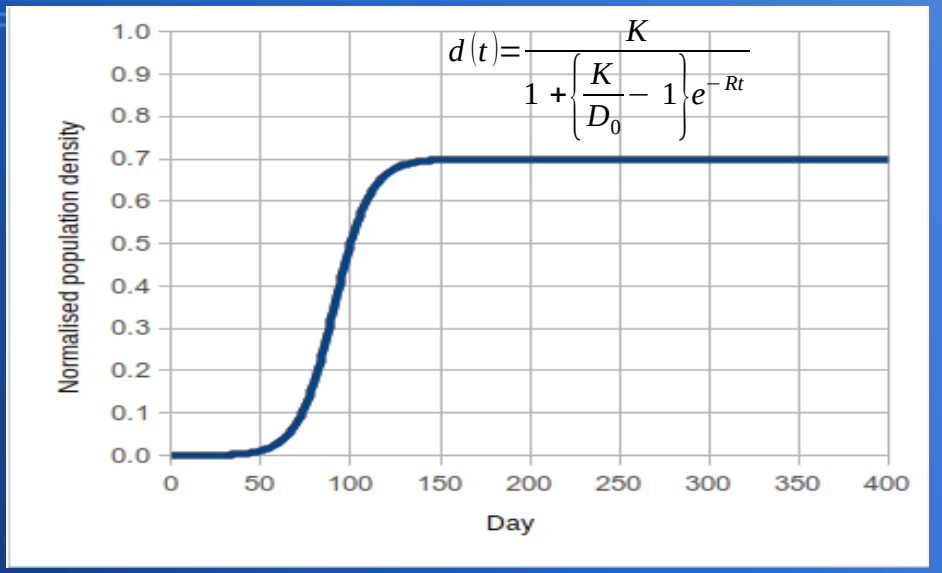
Geographic automata

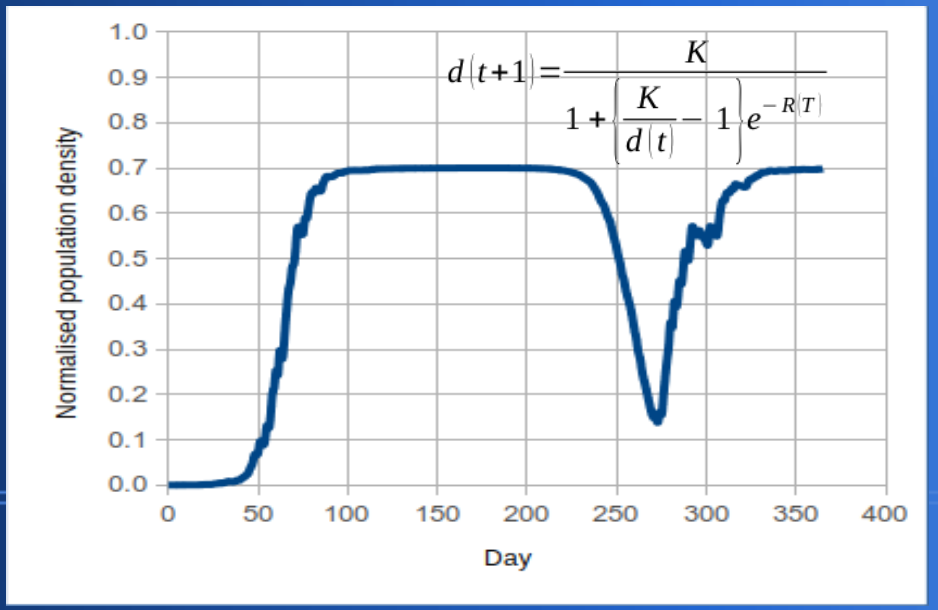
- A study area is viewed as a grid of atomic cells, each of which has an environment, that may or may not support a population over time.

→ what cell size is appropriate for the underlying data?
→ which cells are initially populated?
→ how does within-cell abundance change over time?
→ how/when might the population spread between cells?

Within-cell vector abundance

- Each cell has attributes such as vegetation, elevation, temperature, human population density, rainfall, land use, wind speed, wind direction, etc.
- The user defined 'suitability' attribute determines the carrying capacity of the cell.
- Quiescence occurs in cold weather and may lead to extinction.





Diffusive spread between cells

- Eg., unassisted flight.
- Modelled with a stochastic spatial kernel that depends on the source cell population density, and the destination cell suitability and distance.
- Optional dependencies: temperature, elevation, gradient, wind speed.

Diffusive spread between cells

The probability of a diffusion event occurring on any given day is given by:

$$p_d(t) = 1 - \left(1 - P_d S_d w_d w_t w_e\right)^{d(t)}$$

where

$p_d(t)$ = probability of diffusion occurring on day t

P_d = baseline daily probability of diffusion occurring

S_d = normalised suitability of the destination cell

w_d = distance weight between the source and destination cells

w_t = temperature weight of the source cell (optional)

w_e = elevation weight of the source cell (optional)

$d(t)$ = normalised population density of source cell on day t

Diffusive spread between cells

The baseline daily probability of diffusion P_d is derived with Equation 4.

$$P_d = 1 - \left[1 - p\right]^{1/d} \quad (4)$$

where

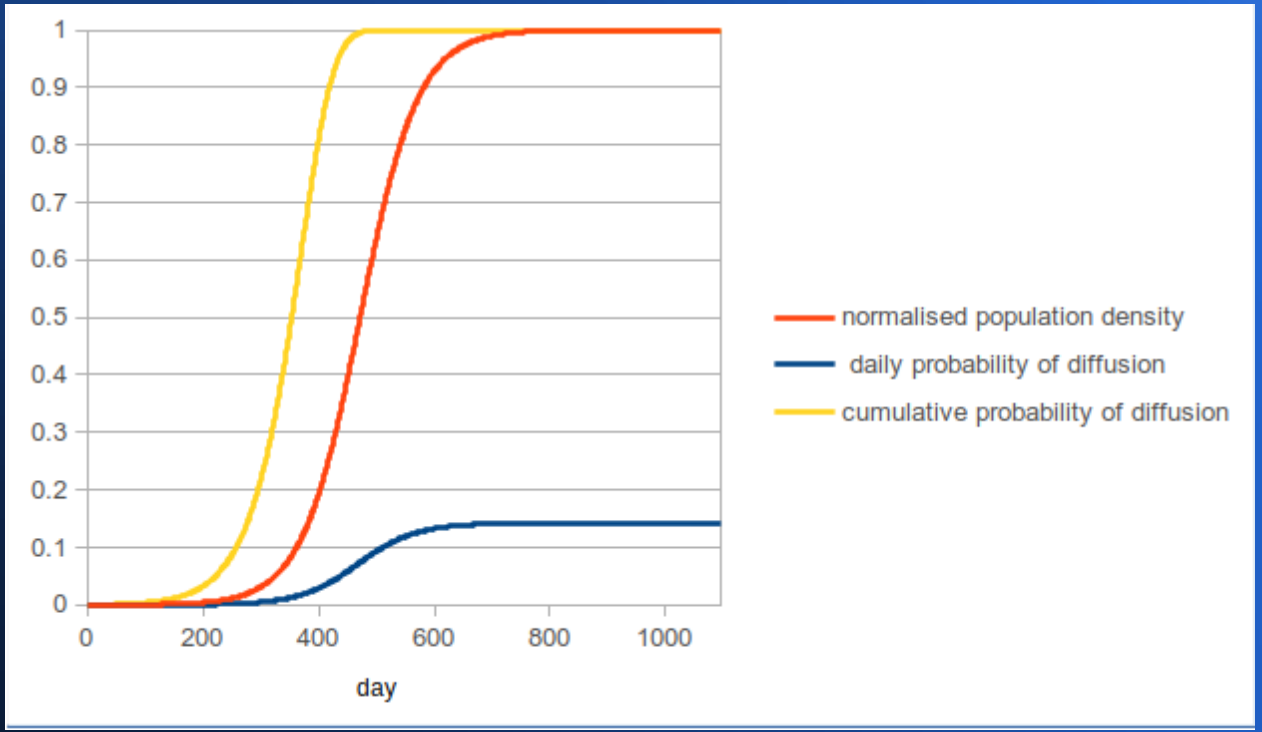
P_d = daily probability of a diffusion event occurring

p = overall probability of a diffusion event occuring at least once in a specified period of interest d

d = the period of interest (days)

- Eg., a 99% chance of a fully populated cell diffusing into an adjacent naive cell within a month equates to a daily probability of 0.14.

Diffusive spread between cells



- $p_d(t)$ for an ideally suitable cell adjacent cell with $P_d = 0.14$

Jump spread between cells

- Modelled with a stochastic jump process that depends on the source cell pest density & destination cell suitability. Optionally depends on temperature and wind speed.
- Jump directions may be random or based on average wind bearings for the nearest weather station.
- Jump distances are sampled from a BetaPERT distribution e.g. BetaPERT(0.5, 10, 75) km

Jump spread between cells

The probability of a jump event occurring on any given day is given by:

$$p_j(t) = 1 - \left(1 - P_j S_d\right)^{d(t)}$$

where

$p_j(t)$ = probability of a jump occurring on day t

P_j = baseline daily probability of a jump occurring

S_d = normalised suitability of the destination cell

$d(t)$ = normalised population density of source cell on day t

Initial vector population

- Point introduction – propagule incursion, e.g., at a port
- Built-in species distribution model – according to configured ranges for temperature, elevation, habitat suitability
- Externally generated density map(s)

Demo

- Seeding the inital population
- Within-cell abundance
- Quiescence
- Between-cell diffusion & jumps