

Revealing the invisible half: model based identification of below-ground competition in plant communities

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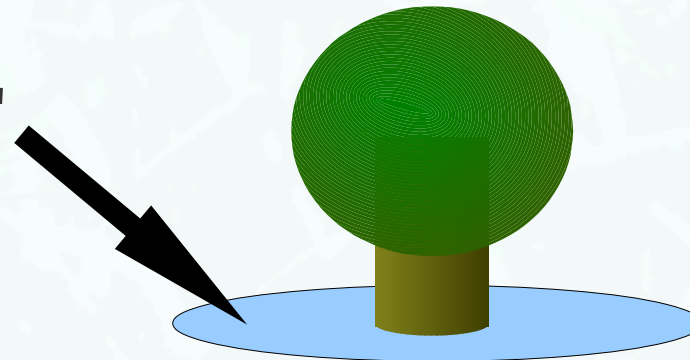
introduction:

- competition: common basis for plant ecology
- crucial concept of IBM
- neighbouring individuals (plants) compete for resources
- competition mode → how the plants (depending on their size / biomass share the resources
- model conception, model assumption
- hard to measure

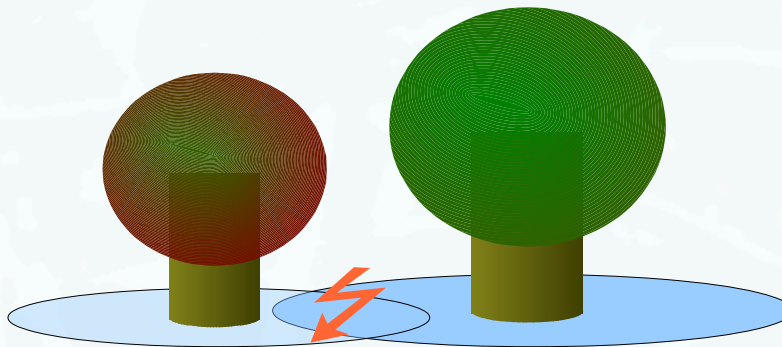
concept of competition mode I:

- a single individual is able to uptake resources within a circle called

'Zone of Influence'
(ZOI)

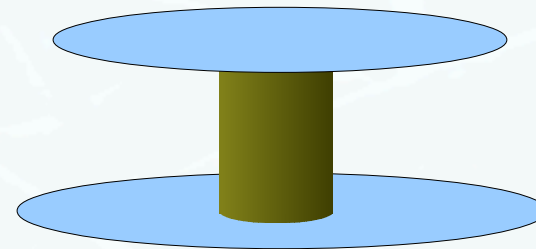
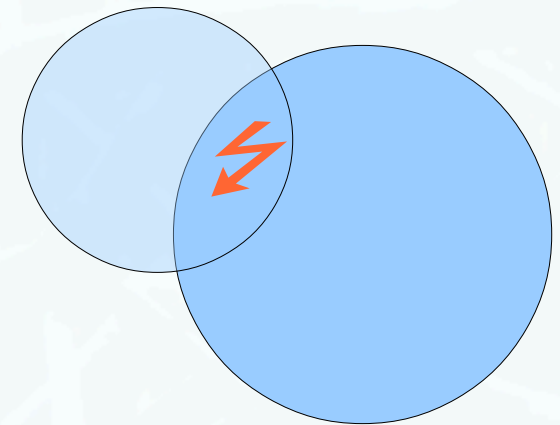


- if ZOI overlaps with ZOI of neighbour → competition



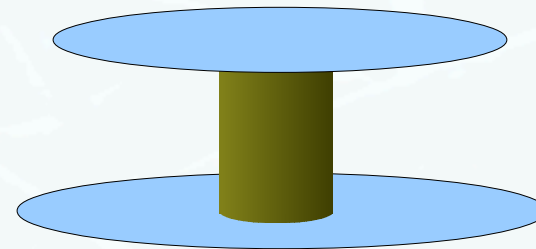
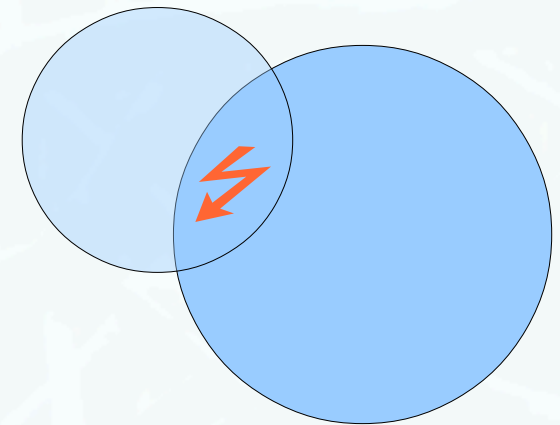
concept of competition mode II:

- competition mode determines the distribution of resources in the overlapping area of the ZOIs
- complete symmetry
 - every individual gets the same
- complete asymmetry
 - the bigger one takes it all
- above-ground / below-ground competition / ZOI
- above-ground for light
 - asymmetric



concept of competition mode II:

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below-ground competition mode (BGCM)



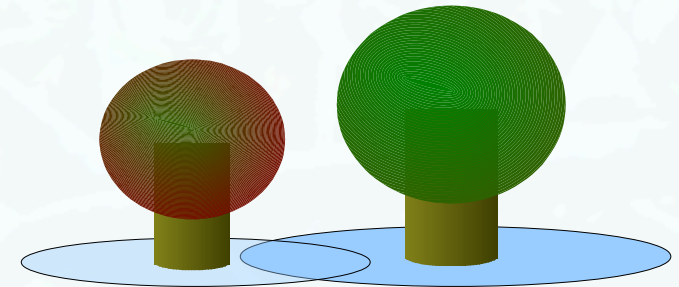
forest:

- all attempts to determine BGCM and relate it to stand parameters failed



greenhouse:

- possibility to measure
- limited in repetitions and scenarios



model:

- unlimited number of scenarios
- unlimited parameter range
- fast & effective

goal of the research:

Is it possible, to measure or determine somehow
the below-ground competition mode (BGCM)?

[above-ground known to be complete asymmetric]

first step:

to find (easier to measure) variables indicating the BGCM

→ model based approach

scenario computation with PI-Model (Lin et al., submitted)



data base (sets of variables and BGCM)

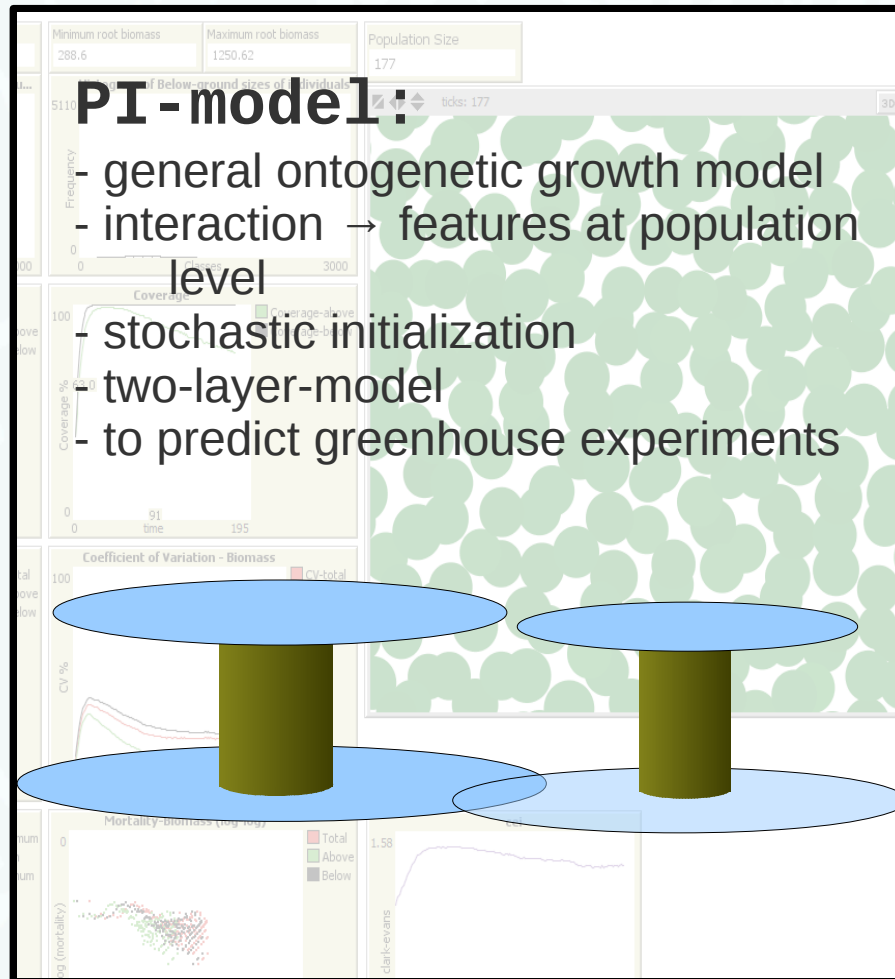


training of SOM (self-organizing feature maps)

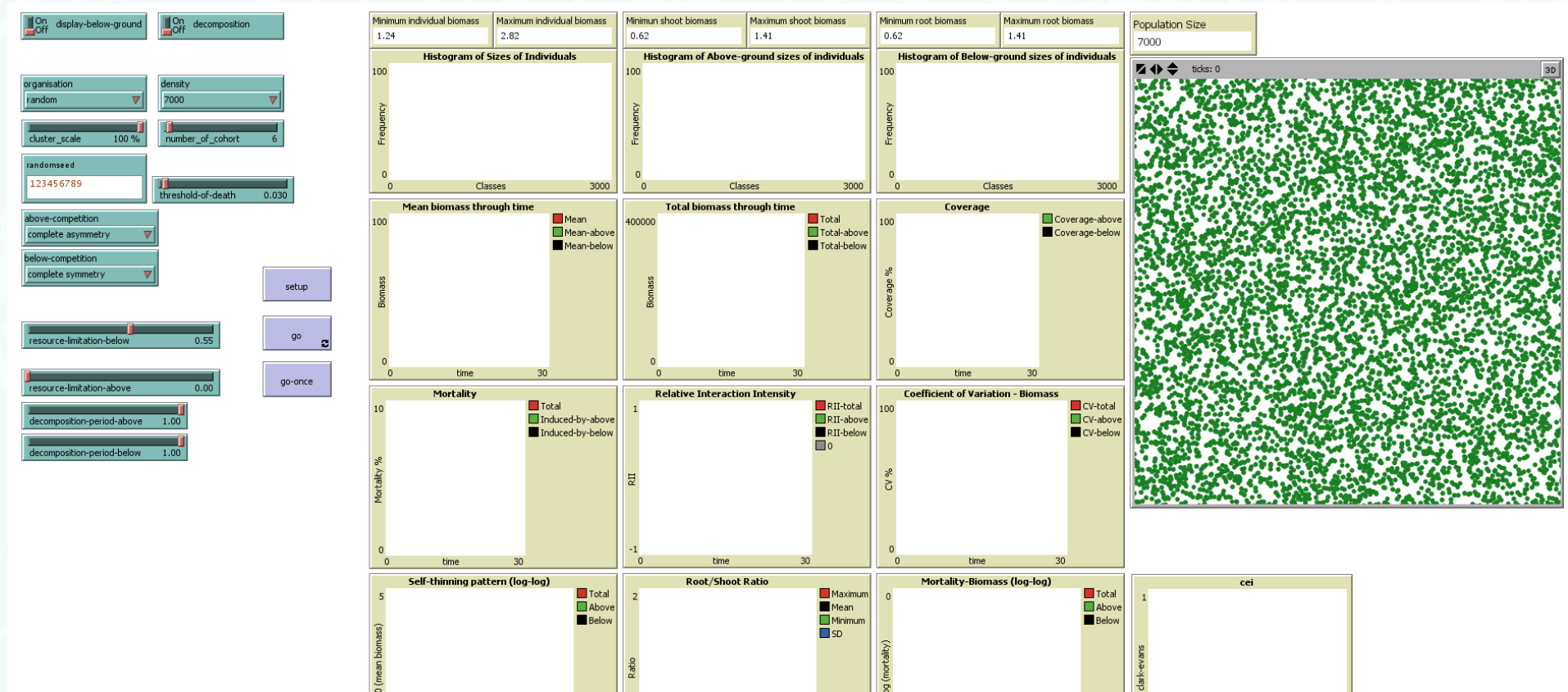


validation (different model runs)

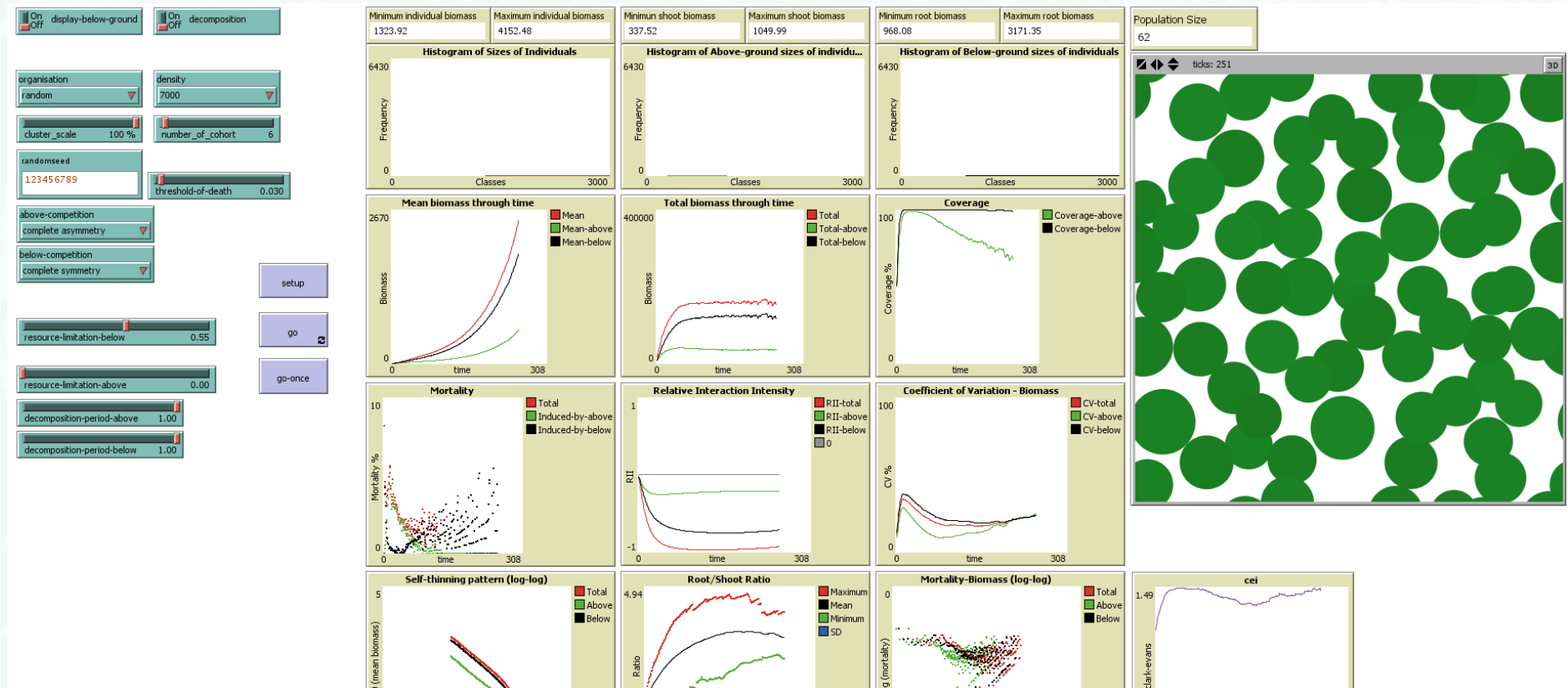
methodology I



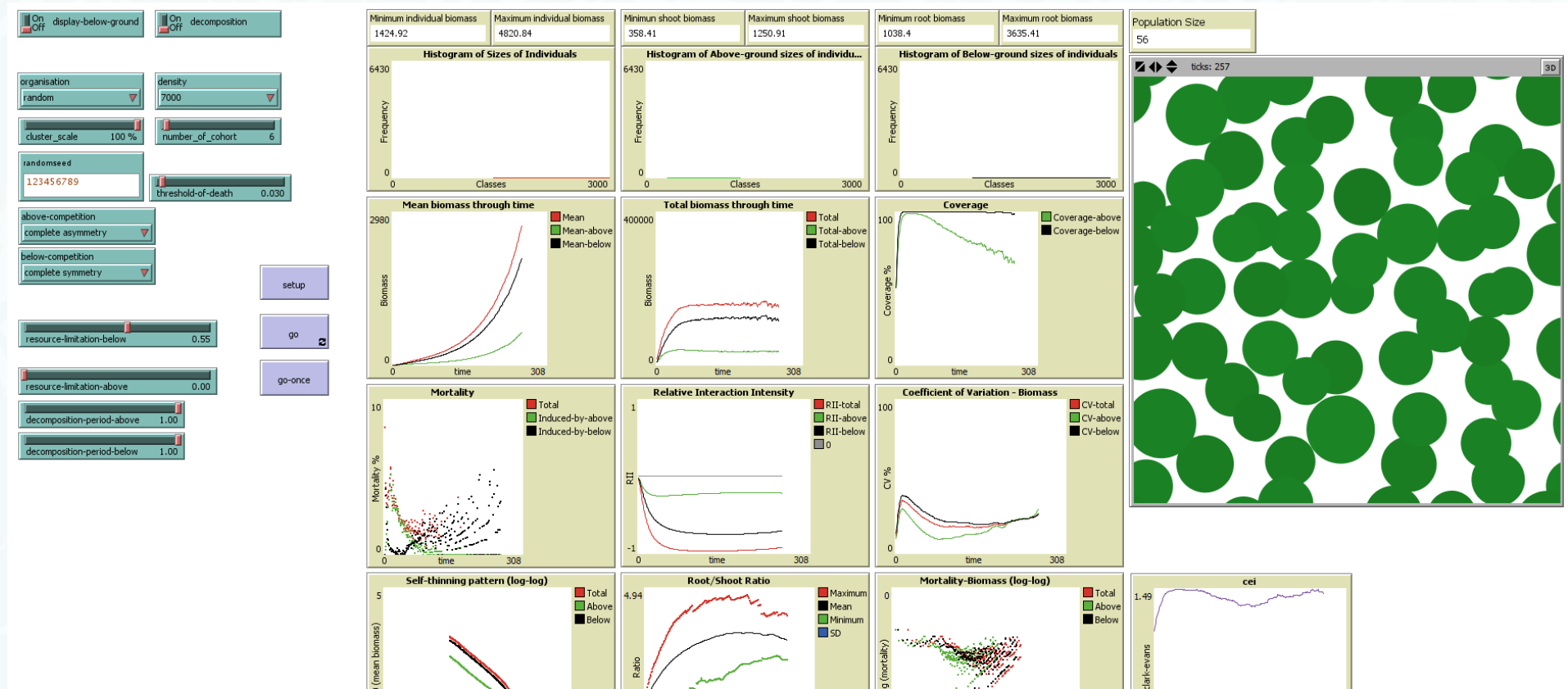
PI-model (LIN et al., submitted)



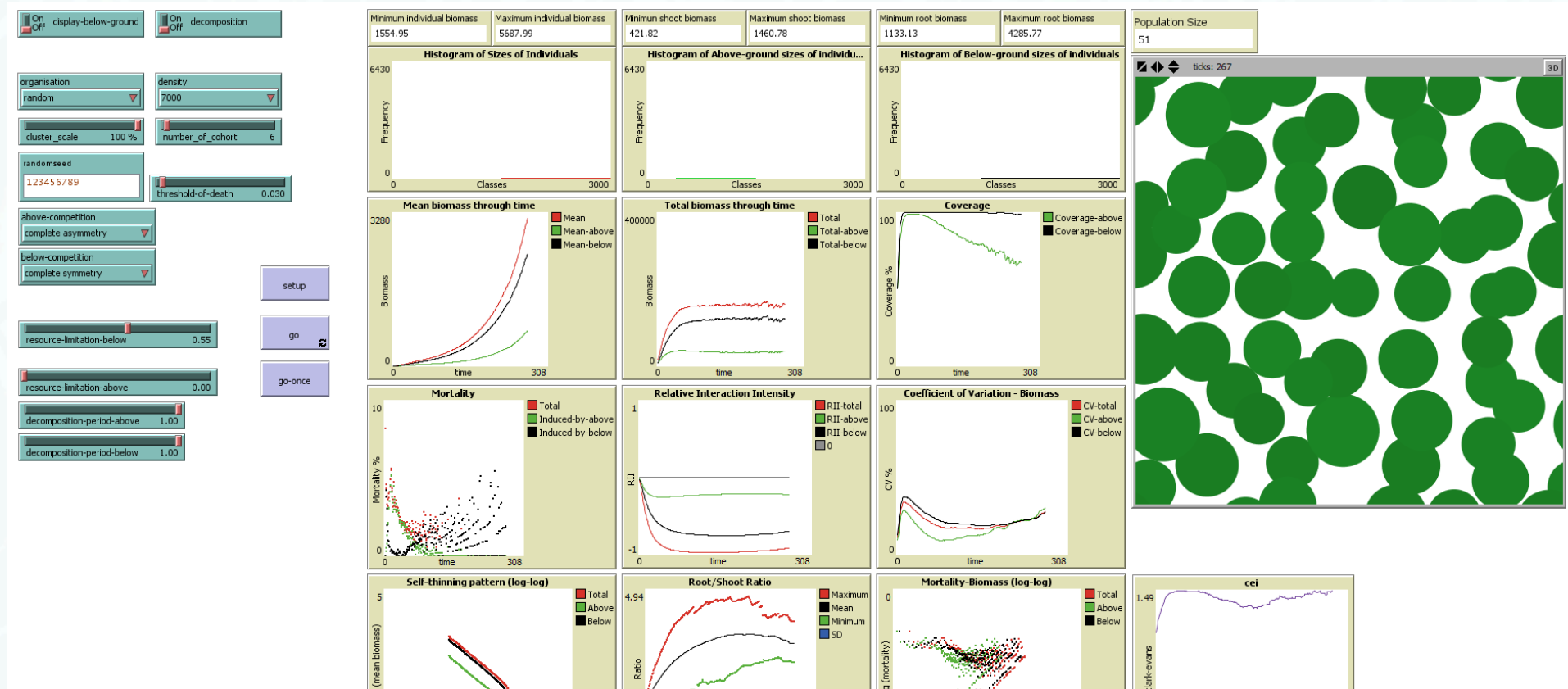
PI-model (LIN et al., submitted)



PI-model (LIN et al., submitted)

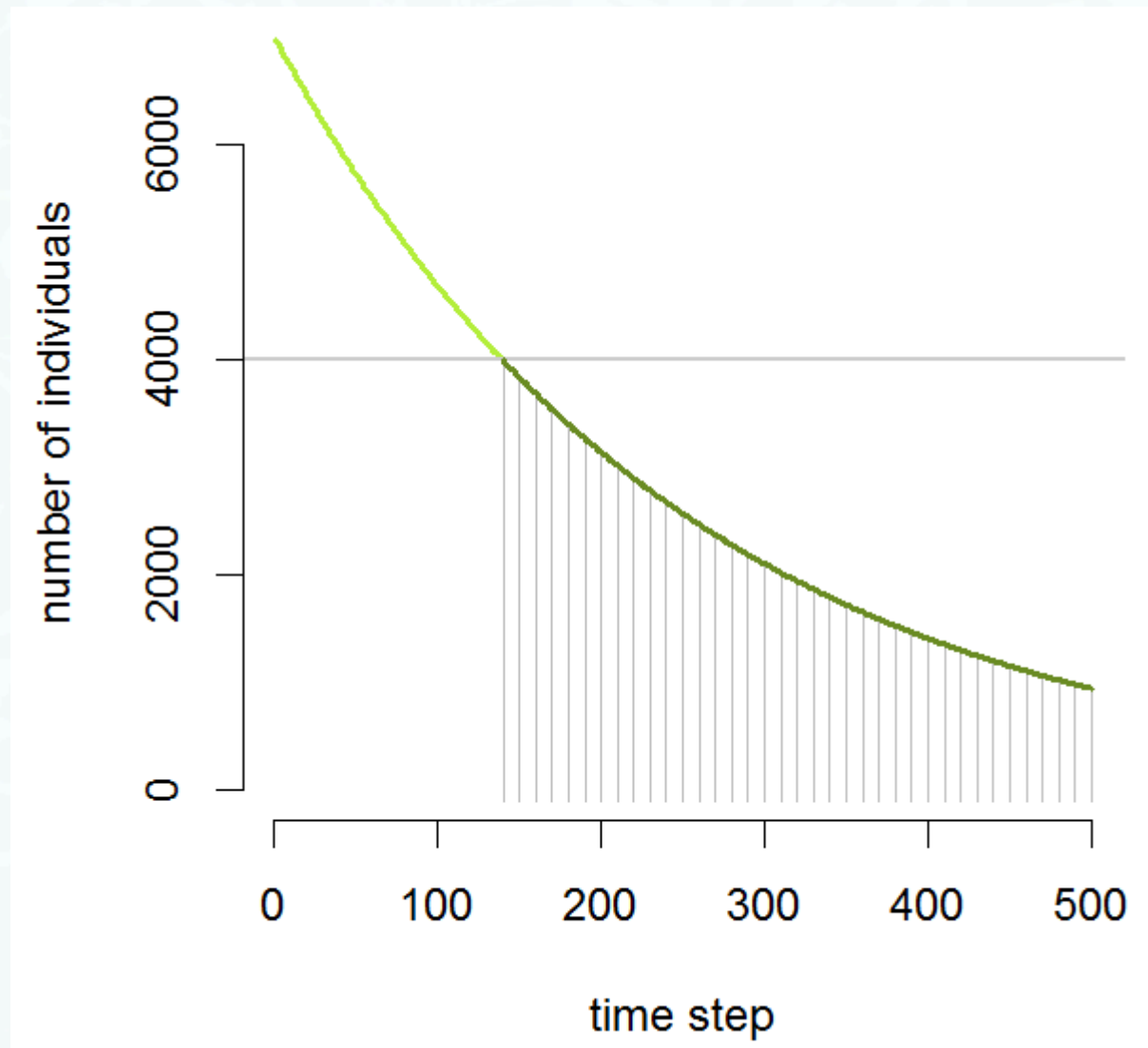


PI-model (LIN et al., submitted)



methodology II

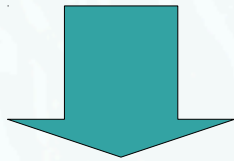
- data of every time step (below 4000 individuals) of every model run
- about 100 model runs with different parameters



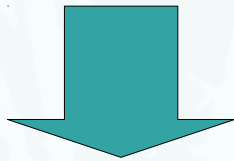
methodology III

Data-Pool:

- all the input- / output-datasets of the PI-model at any time step



- variable selection by potential availability
(e.g. below-ground data are hardly available)



- choice of subsets of BGCM + 2-3 variables → data base

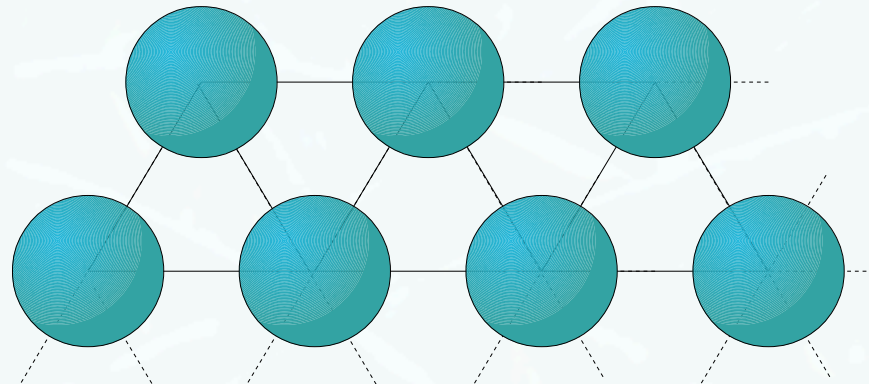
but: functional relation completely unknown
→ tool?

methodology IV

something completely different !!

the model → data base → **other model for calculating the BGCM out of measurable variables:**

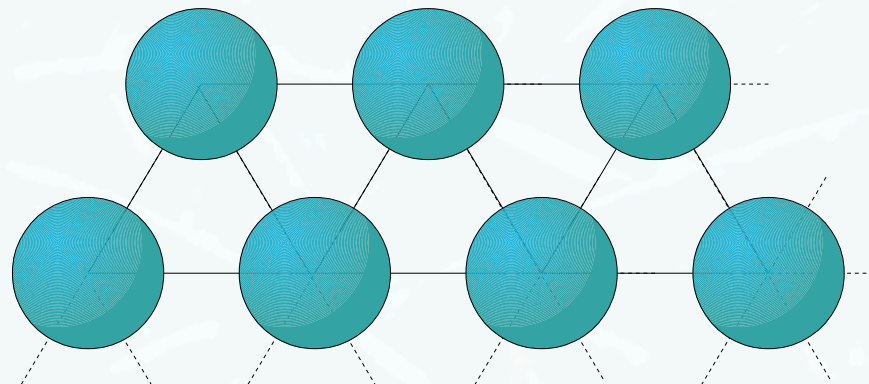
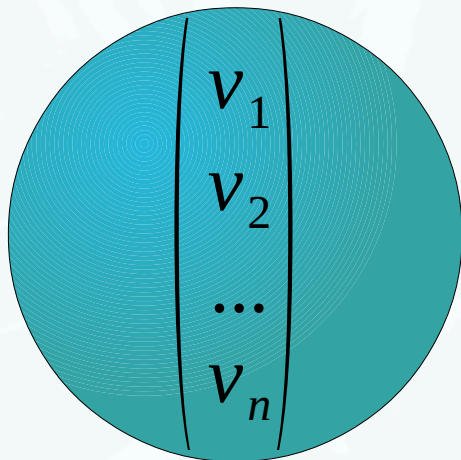
SOM (self-organizing feature maps)



methodology V

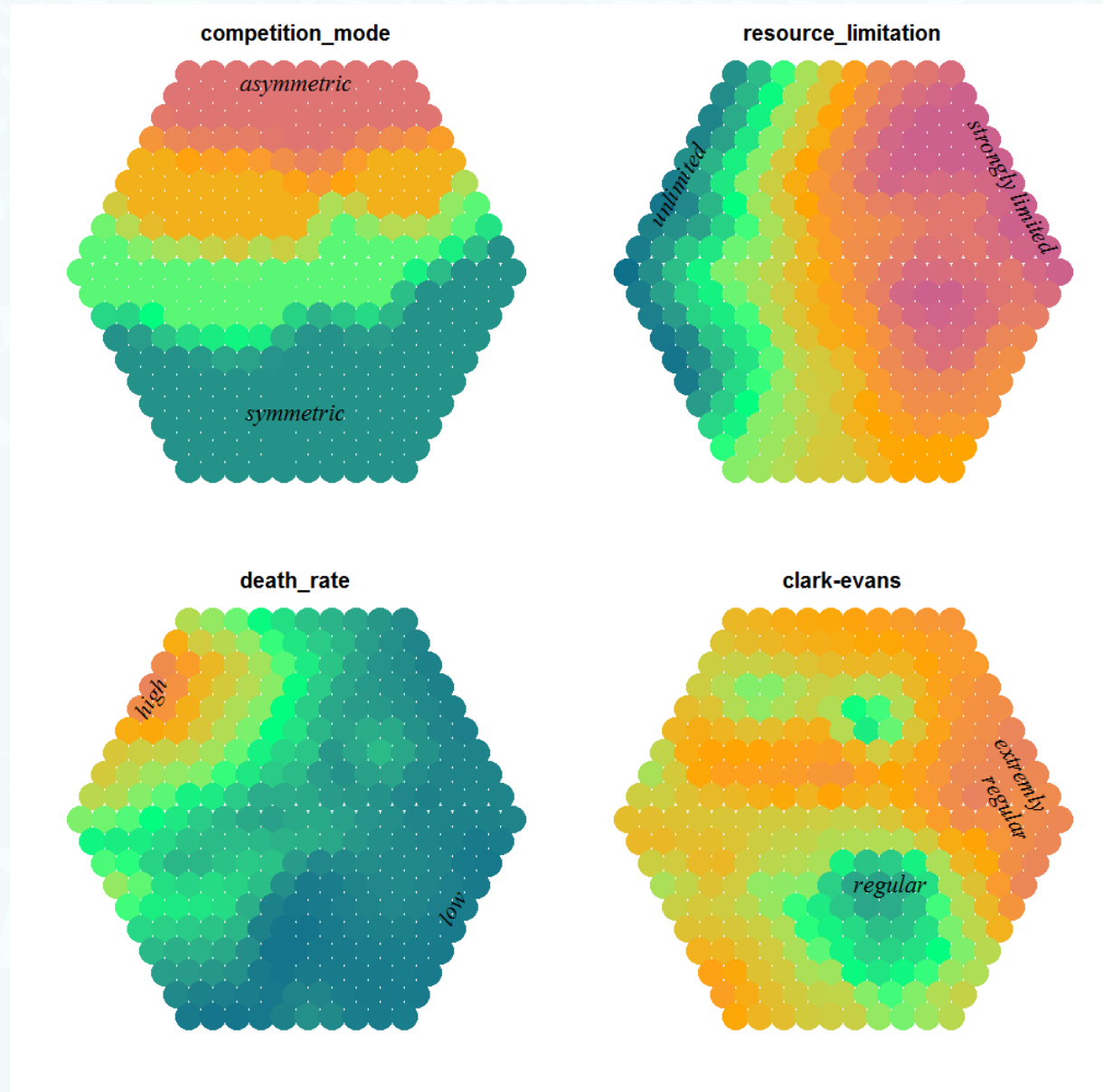
SOM (self-organizing feature maps):

- artificial neural networks
- pattern recognition
- no predefined output-variable
- no predefined function → flexibility
- qualitative interpretability
- generalized patterns of n variables get stored in neurons
- application: search for most similar (uncomplete) pattern → output of missing variable(s)
- neurons organized in a 2-dimensional net in an n -dimensional space (n variables)
- neighbouring neurons → similar patterns



results for the SOM

- competition mode
 - resource limitation
 - death rate
 - Clark-Evans-Index
- (values nor-malized to $\{0,1\}$)



validation of the SOM

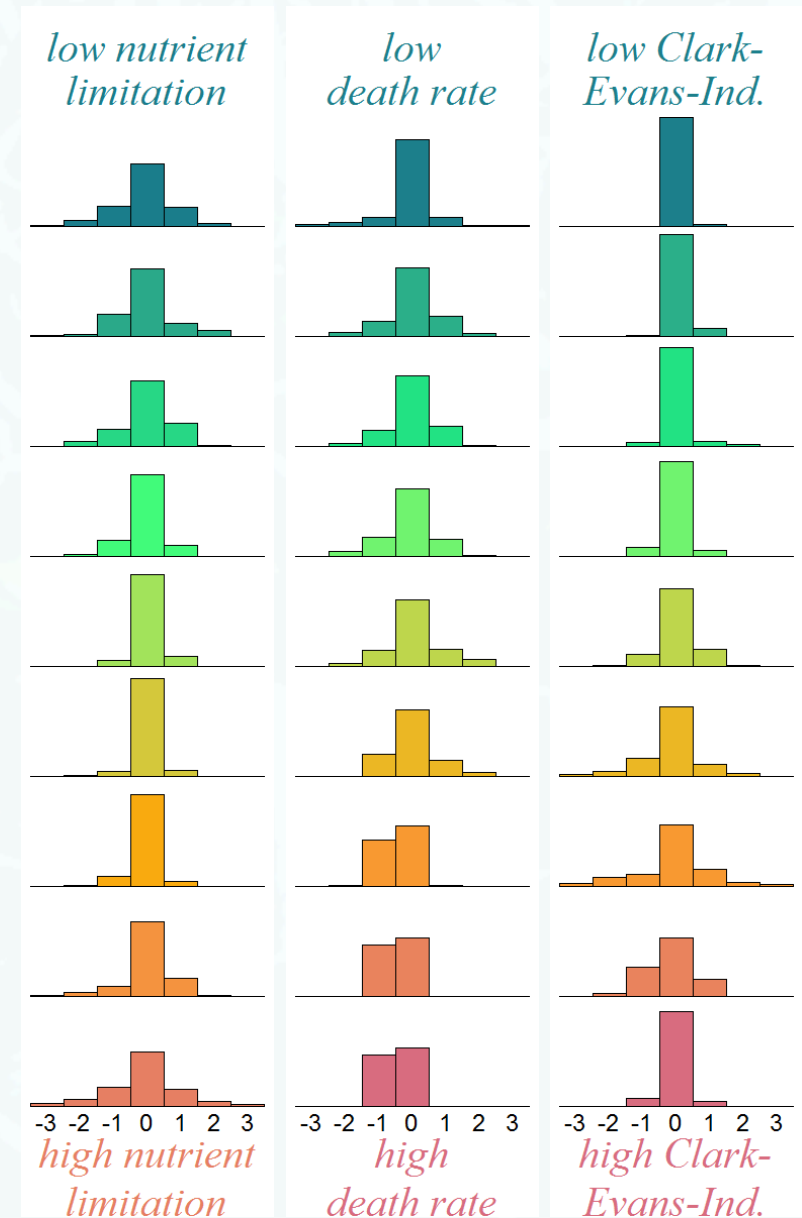
- model runs with different levels of resource limitation / random seeds
- successful pattern recognition
- biggest error in recognition of complete asymmetry

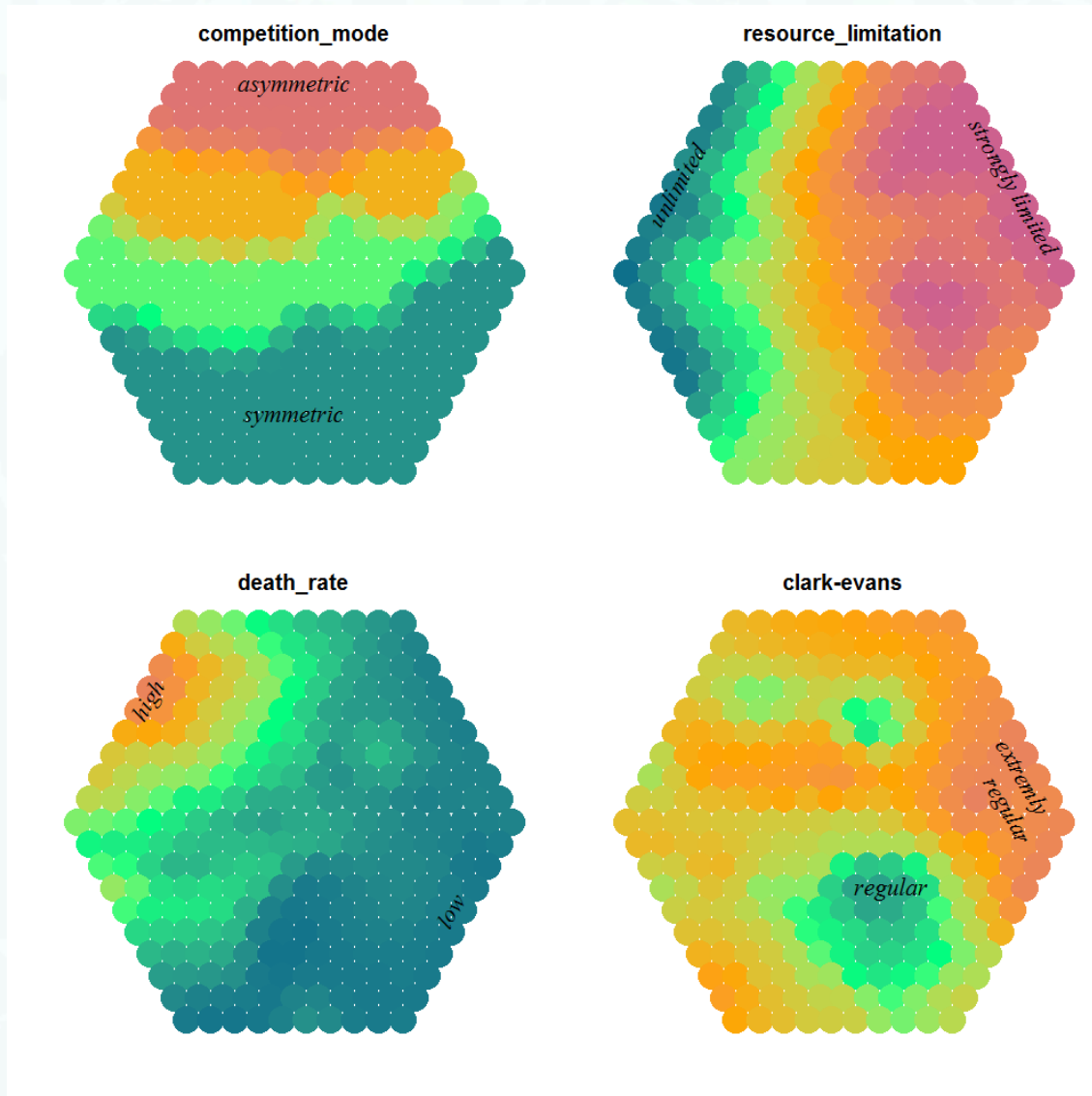
		model input			
		complete	size	allometric	complete
		symmetry		asymmetry	
som output	complete	2912	375	74	61
	size	519	1027	76	136
	allometric	30	125	637	368
	asymmetry	28	83	189	386

validation of the SOM

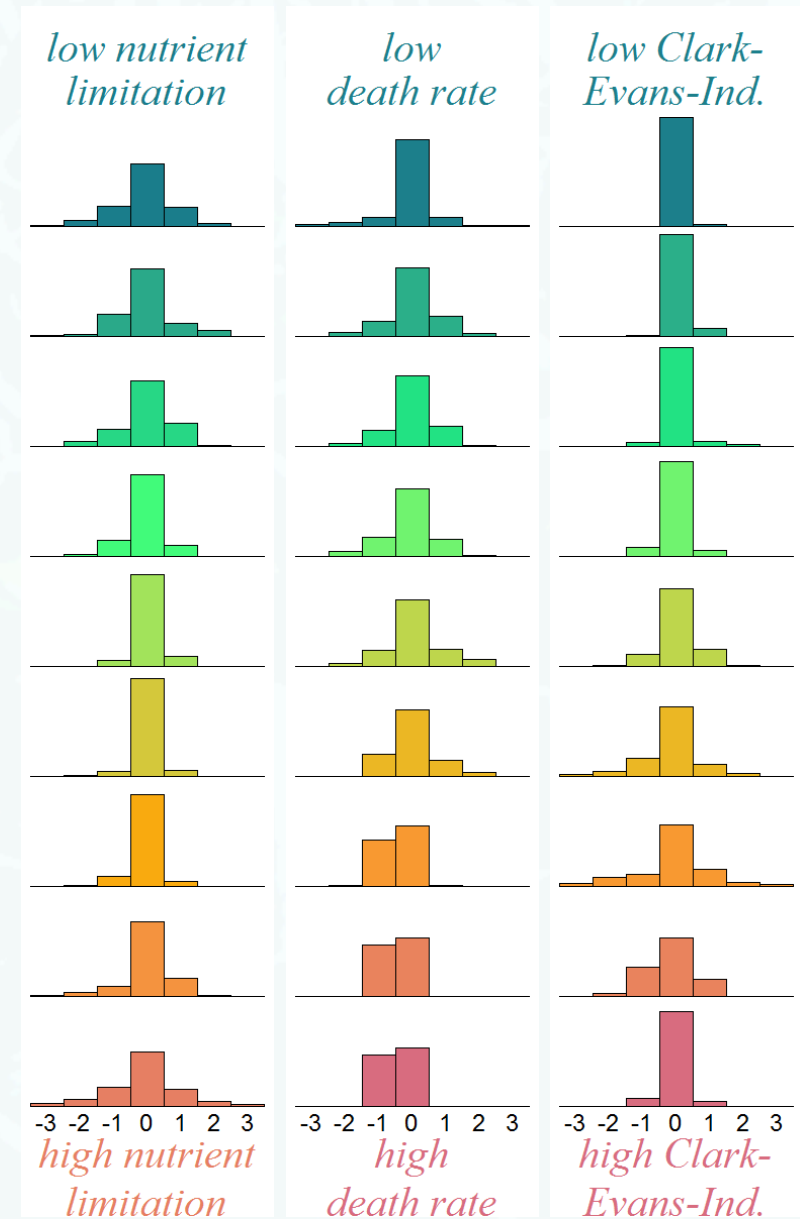
- where are the errors?
 - low / high nutrient lim.
 - higher Clark-Evans-I.
- nutrient limitation:
 - low: subterranean processes less important → BGCM less influential
 - high: sensitive individuals → bigger impact of stochastic component ???
- Clark-Evans-Index:
 - interpretation difficult

classification errors





classification errors



resumé

- methodology capable to identify relevant indicator variables for below-ground competition mode
- relationship between BGCM, nutrient limitation, death rate and spatial pattern found
- uncertainties highest with extremely high/low nutrient limitation and strong regular spatial pattern

next step:

validation with data from greenhouse experiment

- thank
- you!