Towards an adaptive evolutionary and ecological trait-based model

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The Idea

The **ET (Evolutionary Trait) model** sets out to be

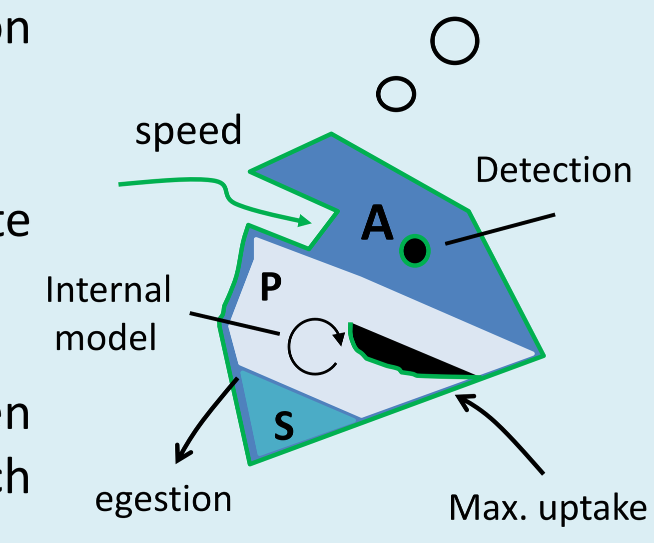
- a spatially explicit Individual-Based-Model (IBM)
- adapting on evolutionary and ecological timescales
- using a concept based on traits and trade-offs

The model is designed to work on as little predefinition as possibly, allowing for the emergent modeling of a wide range of size classes (viruses to whales) and trophic roles (parasites to top predator). It intends to test questions concerning the possibilities and requirements for building a more holistic emergent food web model.
The combination of physical environment, traits and trophic interaction drive the dynamics of this model.

The Agent

- **TRAITS:** define the internal characteristics of the individual in general terms (e.g. type, ecological role). These mutate on evolutionary timescale.
- **STATES:** define the current state of the individual.
- **TAGS:** define interactions between agents (*Who eats whom?*). Each TAG consists of three parts.
- **FUNCTIONS:** combinations of traits and states.

Each TAG consists of:	
value	prefered value
flex	flexibility of value
weight	relative importance of TAG (updated on ecological timescale)

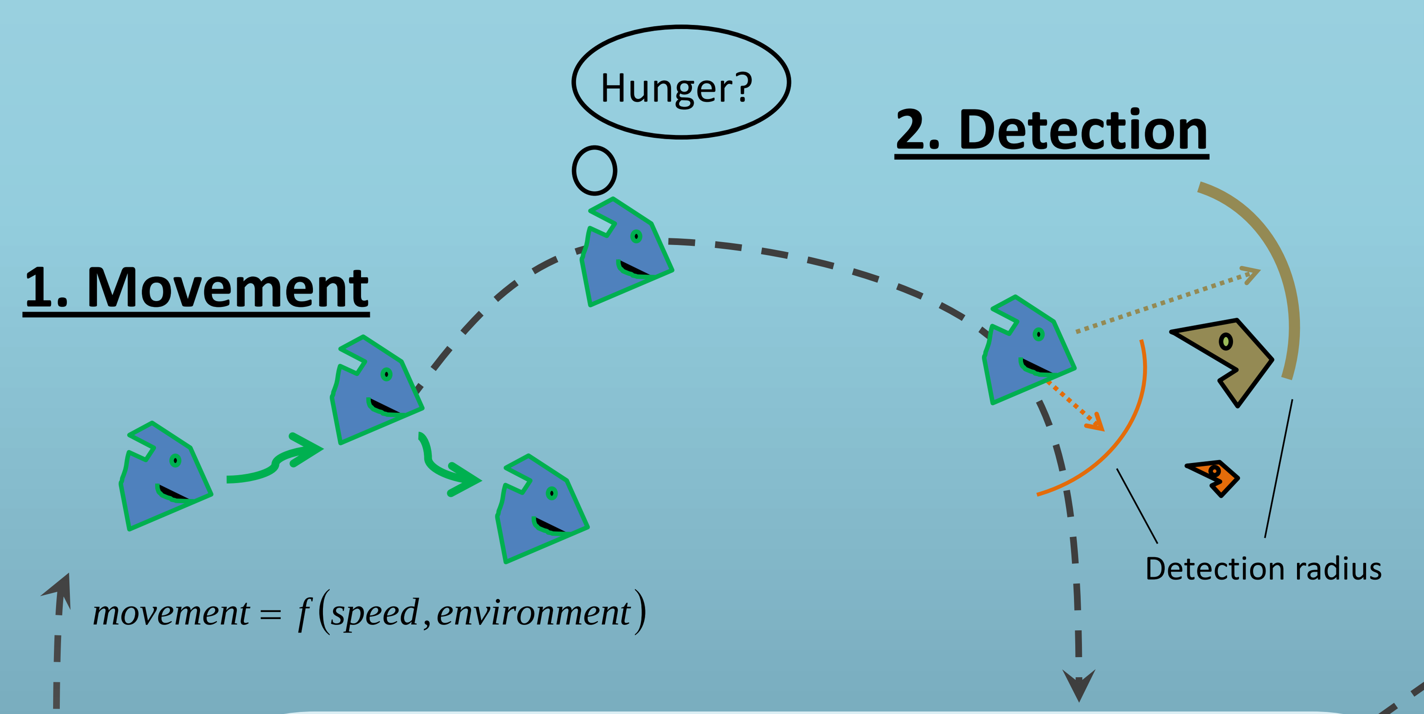


FUNCTIONS	Dependency
Speed	TRAIT-Mobility TRAIT-active STATE-size
Detection	STATE-size (own) STATE-size (other)
Max. Uptake (*Who eats whom?*)	TAGs
Uptake saturation (*Internal model*)	uptake STATE-size
Net uptake (*Internal model*)	Max. uptake Uptake saturation TRAIT-size TRAIT-structure
Assim. efficiency (*Internal model*)	TAG-flex STATE-size
Metabolic losses (*Internal model*)	Speed STATE-size Assimilation
Reproduction (asexual)	TRAIT-size STATE-size
Learning	Net-growth TAG-structure TRAIT-structure
Mutation	STATE-size

		TRAIT	STATE	TAG
Size		Size of maturation	current size	preferred STATE-size, max. overall uptake
Structures	**Active (A)**	optimal proportion of structures	current proportion of structures	preferred proportion of structures
	Passive (P)			
	Storage (S)			
Mobility		General mobility		

1. Movement

2. Detection



$movement = f(speed, environment)$

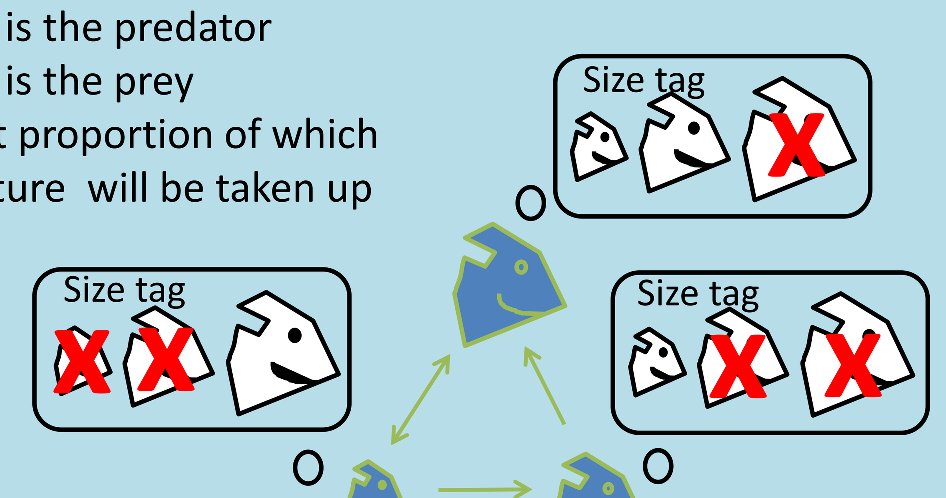
Consumer moves to resource position

Who eats whom?

Upon encounter individuals compare matchscores of TAGs (based on an idea by John Holland[1]) to determine:

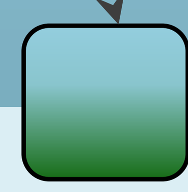
3. Max. uptake

- who is the predator
- who is the prey
- what proportion of which stucture will be taken up



Example (size) of possible trophic interactions

4. Uptake saturation

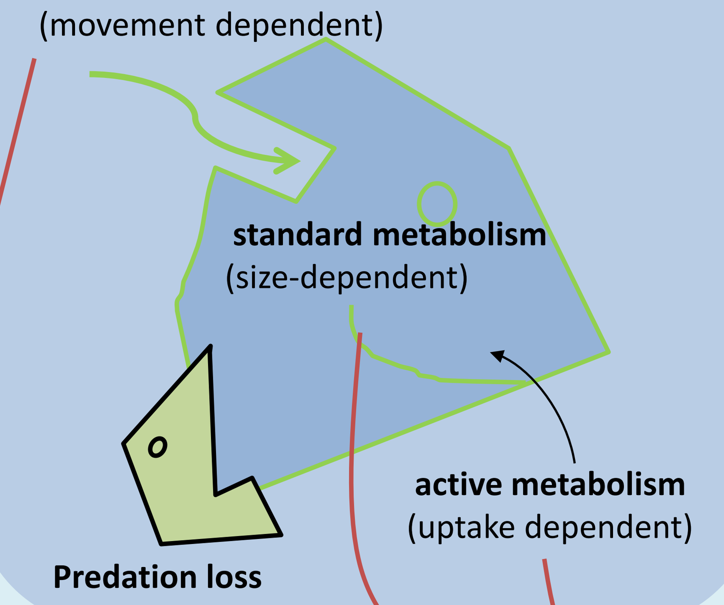


(imagine a stomach to be filled)

Internal Model

7. Loss terms

Storage structure will be used primarily with 100% efficiency, while active and passive structures suffer conversion penalties.



Gross growth

5. Uptake

(Example values)

Gross uptake: A 20 | P 10 | S 70

50 %

30

Max. Direct uptake (own *TRAIT structure*): 20 | 40 | 40

5 | 5 | 5

Indirect uptake (needs conversion)

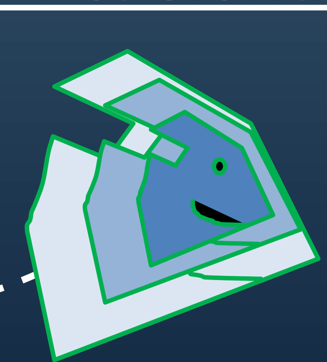
Net uptake: 20 | 10 | 40 | 15

6. Assimilation efficiency

The assimilation efficiency is inversely related to the flexibility of the respective structure TAG. Thus, introducing a trade-off between flexibility and efficency of ressource-uptake (Generalist vs. Specialist).

egestion

8. Net Growth



9. Learning (Ecol. timescale)

Evaluating the structure specific net growth, the TAG-weights of the respective TAG-structures are updated.

10. Asexual reproduction?

11. Mutation (evol. timescale)

Probability to change TRAIT values

Outlook

- Use Genetic Algorithm (GA) for mutation
- Introduce autotrophy (& mixotrophy)
- Introduce sensing trait
- 3D "realistic" environment
- Introduce sexual reproduction

1 : J. Holland (1995) Hidden Order: How Adaptation Builds Complexity

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