Numerical approach and computer simulations of population evolution with migration between locations

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P l a n :

- Model
  - Specification of model parameters
- Results
  - Simulations and numerical calculations
- Conclusions

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The model and model parameters

We consider two habitats (L_1, L_2) occupied by two species (A, B).
Model parameters (b, m, T) & p are:

birth rate	b	
bad mutations rate	m	admitted at birth
resistance to mutations	T	
migration rate between locations	p	

We used

in locations:	L_1	m=0.01	L_2	m=0.04
for species:	A	(b, T)=(0.25, 1)		
	B	(b, T)=(0.20, 8)		

- On output, we get population x = n/N normalized to limited enviromental capacity N.
- The set of parameters were chosen, so that for p=0: A wins competition in L_1 and B is the winner in location L_2.

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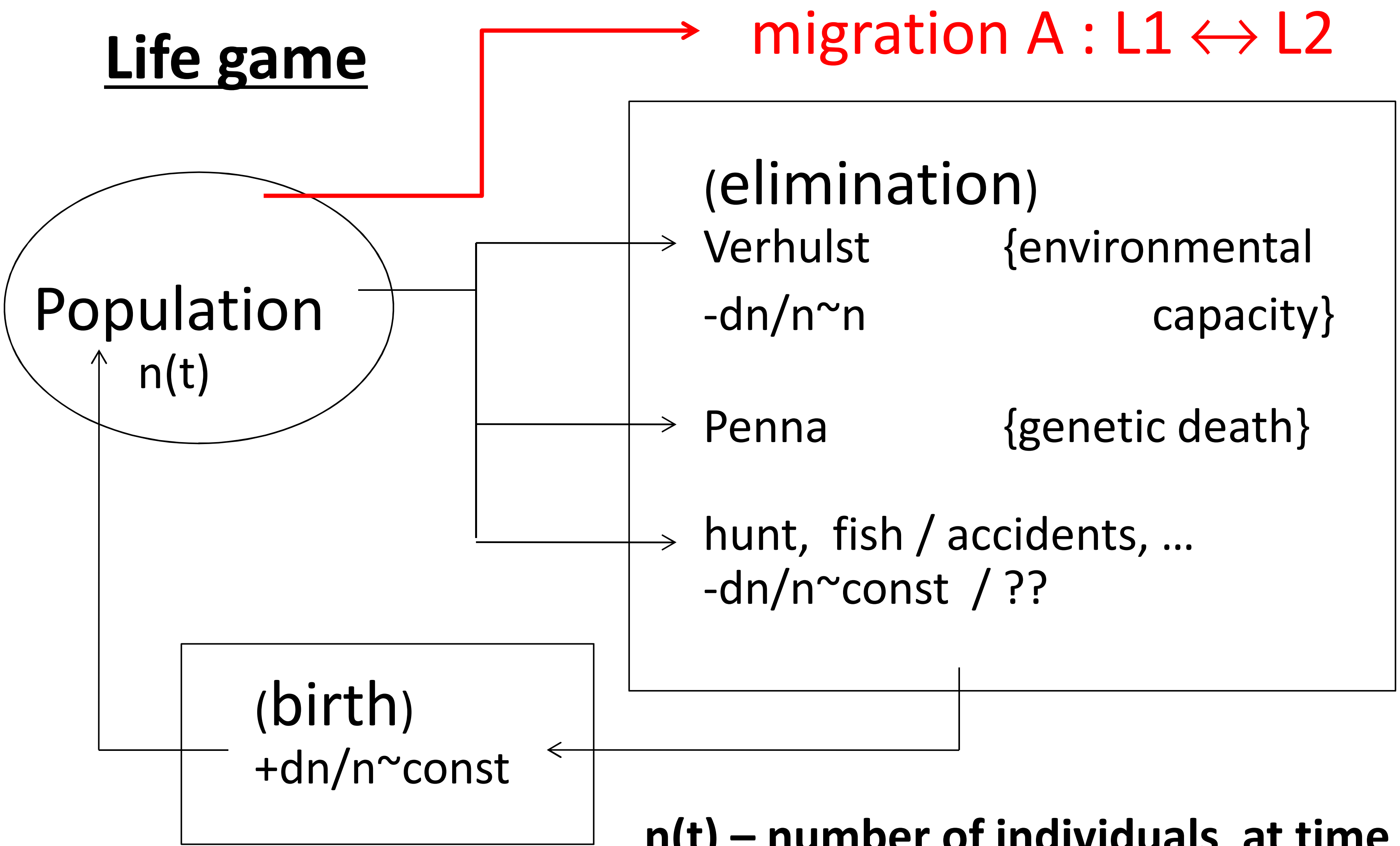
<u>The model and model parameters – (2)</u>

- **We make species A migrants, with probability p of a transfer, and we concentrate on two basic schemes:**
    - **'one way ticket' migration from habitat 1 to 2**
    - **'return visa' migration from 1 to 2 or back from 2 to 1**
- Limiting case $p=0$, within the simplest reference <u>logistic</u> model (with death toll due to the limited environmental capacity only) predicts population $x^*=n/N=b/(1+b)$.
- In simulations we apply <u>Penna</u> model that also accounts for genetic death if number of 'bad mutations' reaches threshold value T. Then population $x < x^*$ is expected in each of the isolated locations.
- **As we mentioned, in each locations only one species takes over, here A wins in 1 while B wins in habitat 2.**
- **More exciting is the case with migration, $p>0$, between habitats.**

Scheme of numerical calculations



n(t) – number of individuals at time t

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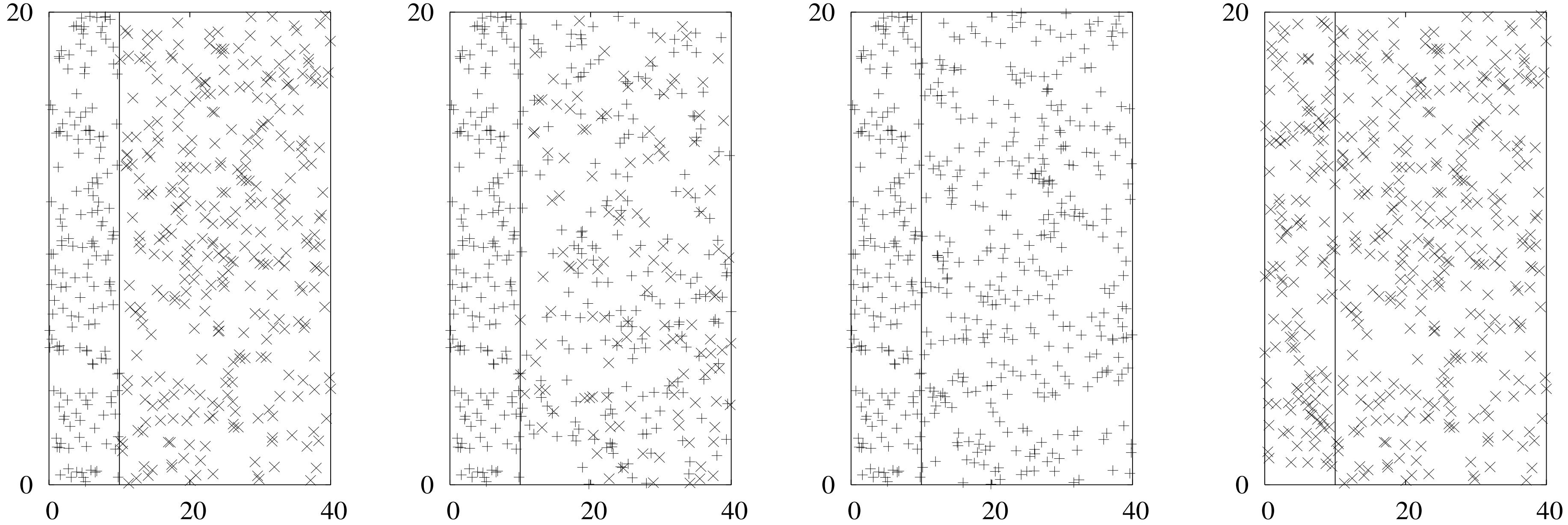
Results for 'one way ticket' migration species A from habitat L_1 to L_2

from left scheme: p = 0, moderate p ($p<p_1$), high p, panic ($p > p_2$)



population splits: 10+01 (p=0) coexistence: 10+11 (p=0.0008) emigrants wins: 10+10 (p=0.012) natives wins: 01+01 (p=0.03)

Conclusions

- With no migration, one species takes over and wins.

- For ‘one way ticket’ migration scheme:
  - population of emigrants is a linear function of p,
    for $0 < p < p_1 = 0.001$ – type A occupies location L_1
    and we get a mixed population in L_2
  - we get saturation for $p_1 < p < p_2 = 0.02$,
    type A wins in both habitant L_1 and L_2
  - catastrophic exodus-like reverse effect for $p > p_2$,
    with total extinction of species A,
    species B wins in both locations L_1 and L_2.

- For ‘return visa’ scheme: population of emigrants reaches some kind of a dynamic equilibrium in habitat L_2 while in L_1 species A wins.

THANK YOU FOR ATTENTION