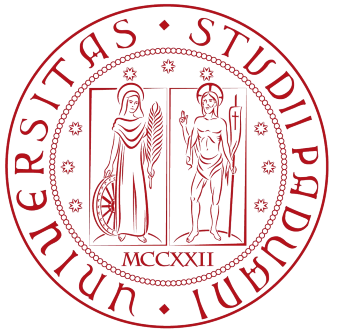


Language Competition Dynamics

Author: Joan Verguizas I Moliner

13/09/2023

Model Description

- 2 Dimensional Lattice-like Structure of N = L x L nodes.
- Each Node is connected to its first neighbors.

- We sample a random vertex. Then, we compute local densities σ to get the transition probabilities.
- We repeat this for N epochs.

- Start By Assigning each node to a linguistic community randomly.

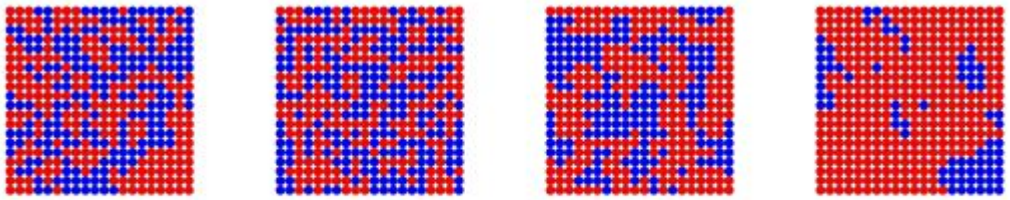
- Two models: Abrams-Strogatz model & Bilingual model.

Model Description

Abrams-Strogatz model

$$p_{i,A->B} = \frac{1}{2}\sigma_i^B \qquad p_{i,B->A} = \frac{1}{2}\sigma_i^A$$

- Abrams-Strogatz model: A and B linguistic communities.
- Agents jump from A to B.



(a) Epoch 0 (b) Epoch 100 (c) Epoch 2500 (d) Epoch 50000

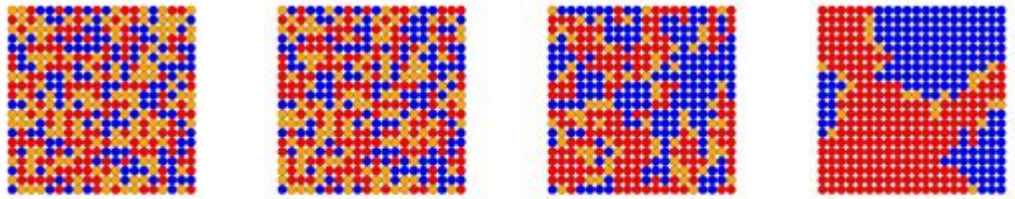
- Epochs go by -> Formation of linguistic community structure for A and B agents.

Model Description

Bilingual model

$$p_{i,A->AB} = \frac{1}{2}\sigma_i^B \qquad p_{i,B->AB} = \frac{1}{2}\sigma_i^A$$

$$p_{i,AB->B} = \frac{1}{2}(1-\sigma_i^A) \qquad p_{i,AB->A} = \frac{1}{2}(1-\sigma_i^B)$$



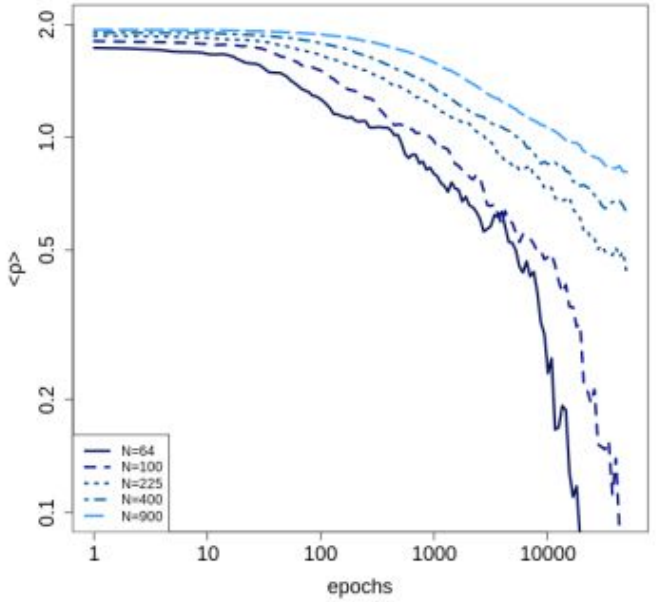
(a) Epoch 0 (b) Epoch 100 (c) Epoch 2500 (d) Epoch 50000

- Bilingual Model: AB bilingual agent.
- Bilingual agent acts as an in-between transition for the monolingual communities transition.

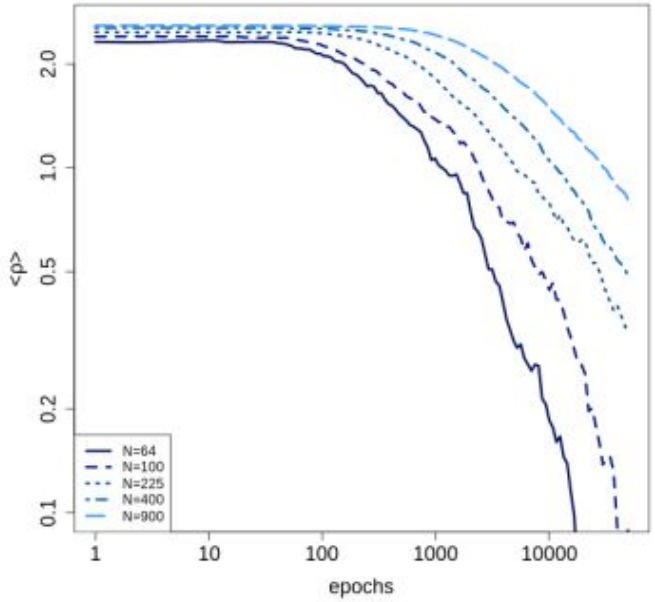
- AB agents do not form a linguistic community.

Model Analysis

Number of Nodes N



(a) Abrams-Strogatz



(b) Bilingual

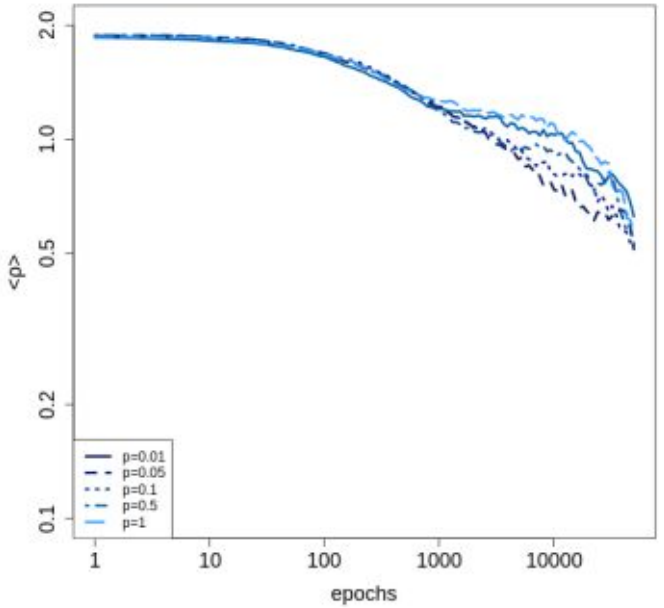
Number of Nodes (N)	γ Parameter	
	Abrams-Strogatz	Bilingual
64	0.298	0.428
100	0.260	0.305
225	0.148	0.193
400	0.123	0.152
900	0.096	0.098

$$< \rho > \sim t^{-\gamma}$$

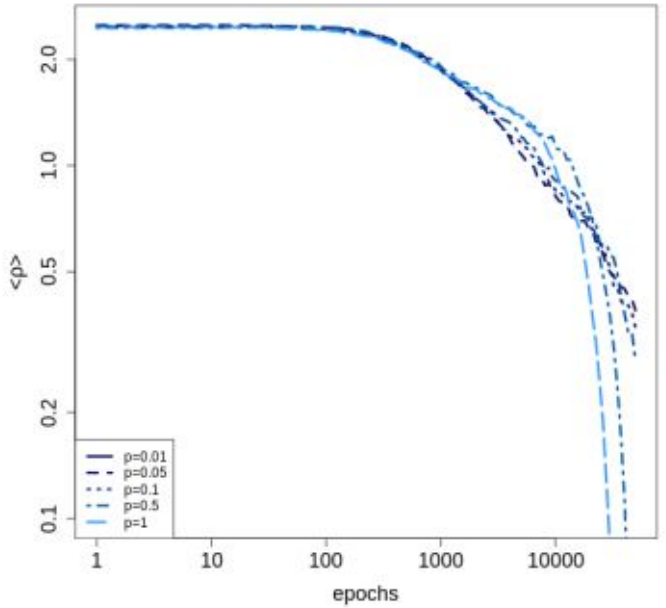
- ρ is the average interface density (average number of of links joining nodes in the network which are in different states).
- ρ decays as a power law respect to the number of epochs.

Model Analysis

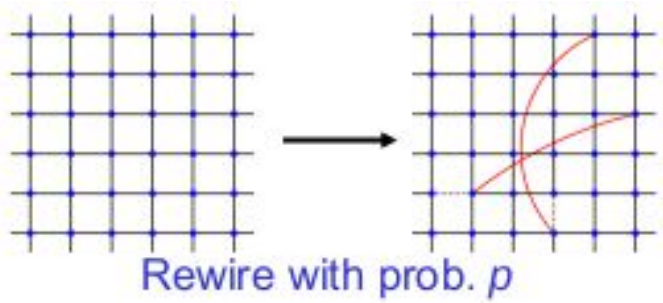
Small-World Topology



(a) Abrams-Strogatz



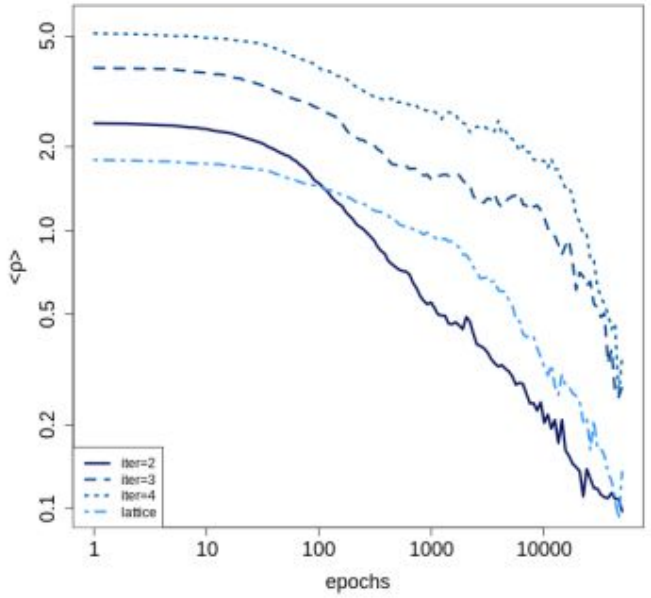
(b) Bilingual



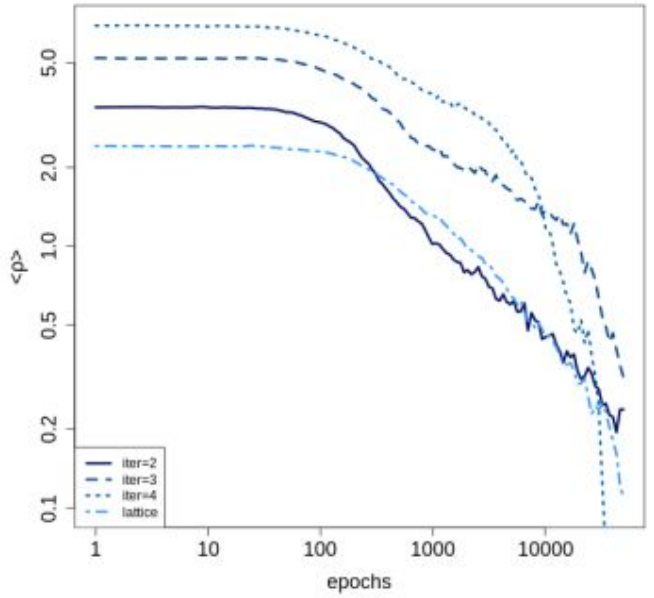
- Increasing p produces a fast extinction in the bilingual model.
- The effect of increasing p produces close to no change.

Model Analysis

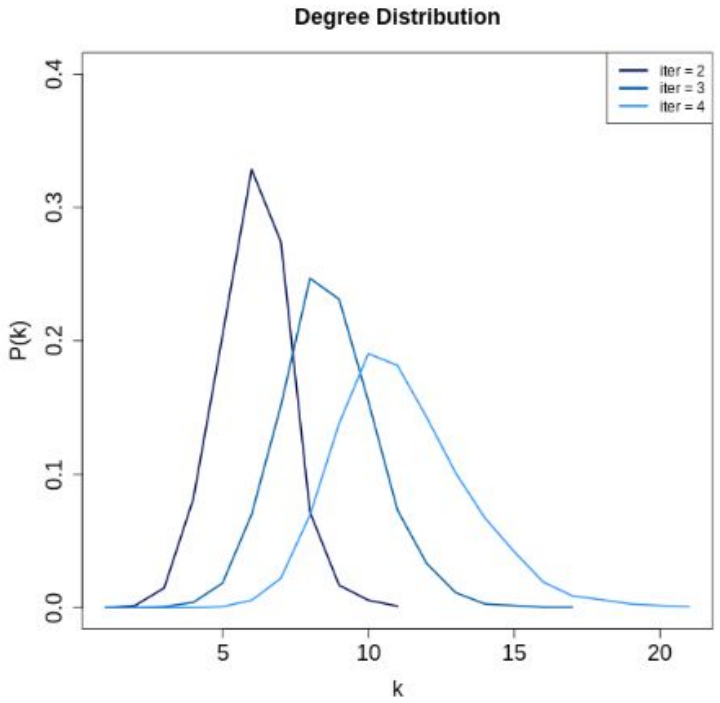
Community Structure Topology



(a) Abrams-Strogatz



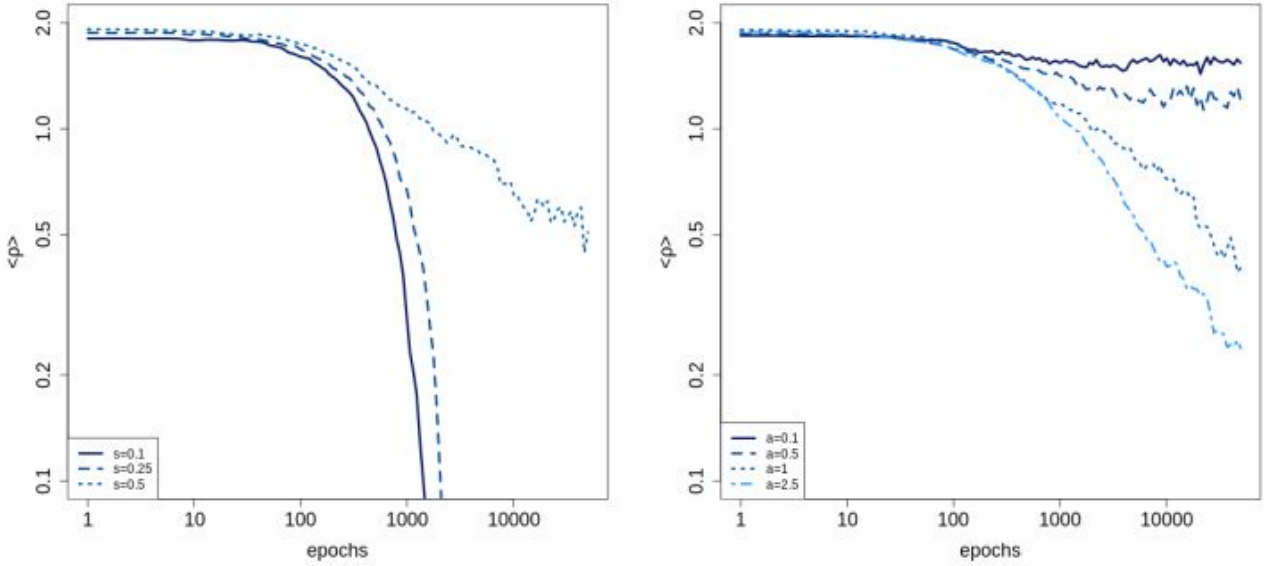
(b) Bilingual



- Introduce a random attachment with a search for new contacts among the neighbors of those random edges. The process is repeated 2-4 times.
- Community structure seems to introduce resilience (slower convergence).

Model Analysis

Prestige and Volatility



(a) Prestige (b) Volatility

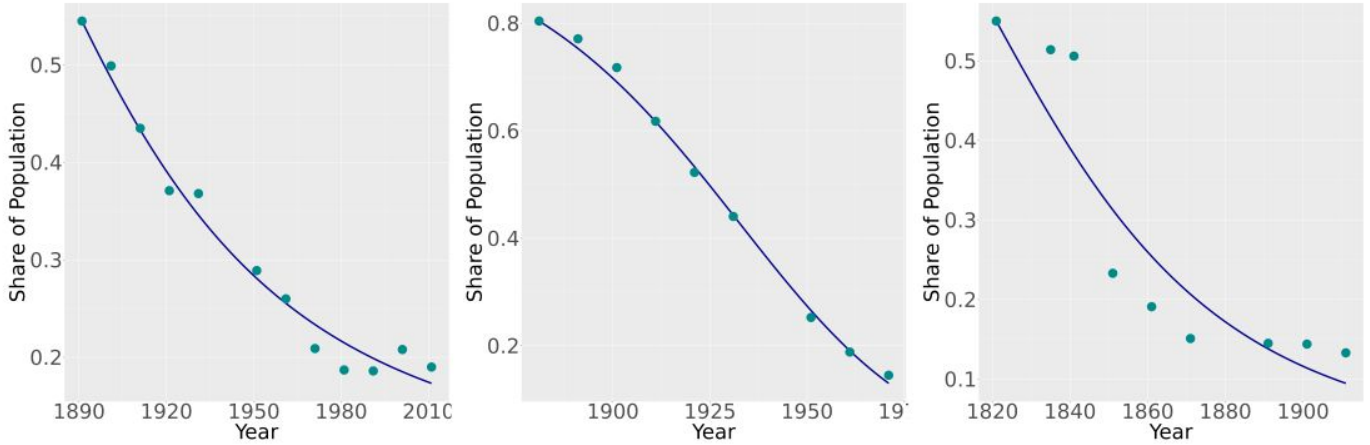
$$p_{i,A->B} = (1-s)(\sigma_i^B)^a \qquad p_{i,B->A} = s(\sigma_i^A)^a$$

- Prestige (s): Status of the competing languages. 0.5 at equilibrium.
- Volatility: Ease at which languages change. 1 at equilibrium.

Dynamics of Language Death

$$\frac{dx}{dy} = \sigma_B p_{B->A} - \sigma_A p_{A->B}$$

Languages	Parameters	
	Prestige (s)	Volatility (a)
Welsh	0.453	1.245
Irish	0.898	1.274
Gaelic Scottish	0.296	0.950



(a) Welsh (b) Gaelic Scottish (c) Irish

- Fitted data that we gathered to the ODE to get the s and a values.
- Volatility, similar to the one found by the paper: 1.31 ± 0.25.
- Prestige similar than paper: Welsh (0.43 to a computed result of 0.453), Gaelic (0.33 to 0.296).