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Lexicons from Noise

Emergent Lexicons in Multi-Agent Spatial Configuration

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Contents

- **Previous Research**
  - Description
  - Limitations
- **General Objectives**
  - Overcoming the limitations
  - Objectives
- **Model Description**
  - Learning Mechanism
  - The Observational Game (Modified)
  - Spatial Dynamic
- **Results**
- **Concluding Remarks Discussion**

Previous Research: Description

Our model is based on Steels (1996; 2003) and Vogt and Coumans' (2003) research about 'Language Games'

- An interaction between two agents, a speaker and a hearer (randomly selected)
- These agents share a particular contextual setting (which includes other objects or agents)
- The speaker identifies an object (called the topic of the dialog) from the contextual setting and utters to the hearer the topic by using 'linguistic' means
- The 'language game' succeeds when the hearer manage to identify the topic

Previous Research: Limitations

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However, we depart from these previous studies because they suppose:

- Most of the 'language games' so far assume that agents have direct access to each other's meanings (direct feedback whether the right association has been learned)

  → *But meaning can be understood only in context; our minds are separate and individual (so we don't have direct access to the other's mind)*

- Interactions always involve just two 'players' in each game ('speaker' and 'hearer')

  → *Unrealistic assumption because interactions can involve two or more agents*

- While the interaction between two agents takes place, what happens to the other agents?

  → *They become completely deaf!*

- The topic of the game (or the context from which the topic is selected) is randomly picked up from the world

  → *Agents have super-vision; they can see all the world*

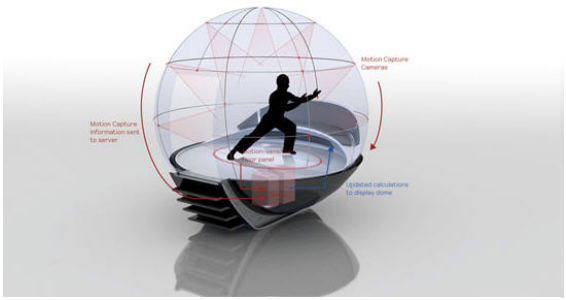
Overcoming the limitations

The spatial configuration can be helpful to overcome the limitation of previous research:

- We borrow the geographical approach from ‘New Ties Project’ (2006) in order to model the emergence of a lexicon
- The hearer is aware of the game’s topic because he can see it; the hearer is aware of the word-topic relation because he can hear the speaker’s voice
- The voice and the sight are limited; co-presence object-speaker-hearers is required → ‘Joint Attention’
- One or more agents can hear the speaker’s utterance, within the limits of the interaction (given by the range where both the voice is audible and the object is visible)
- The topic of the game (or the context from which the topic is selected) must be visible, otherwise there is nothing to talk about.

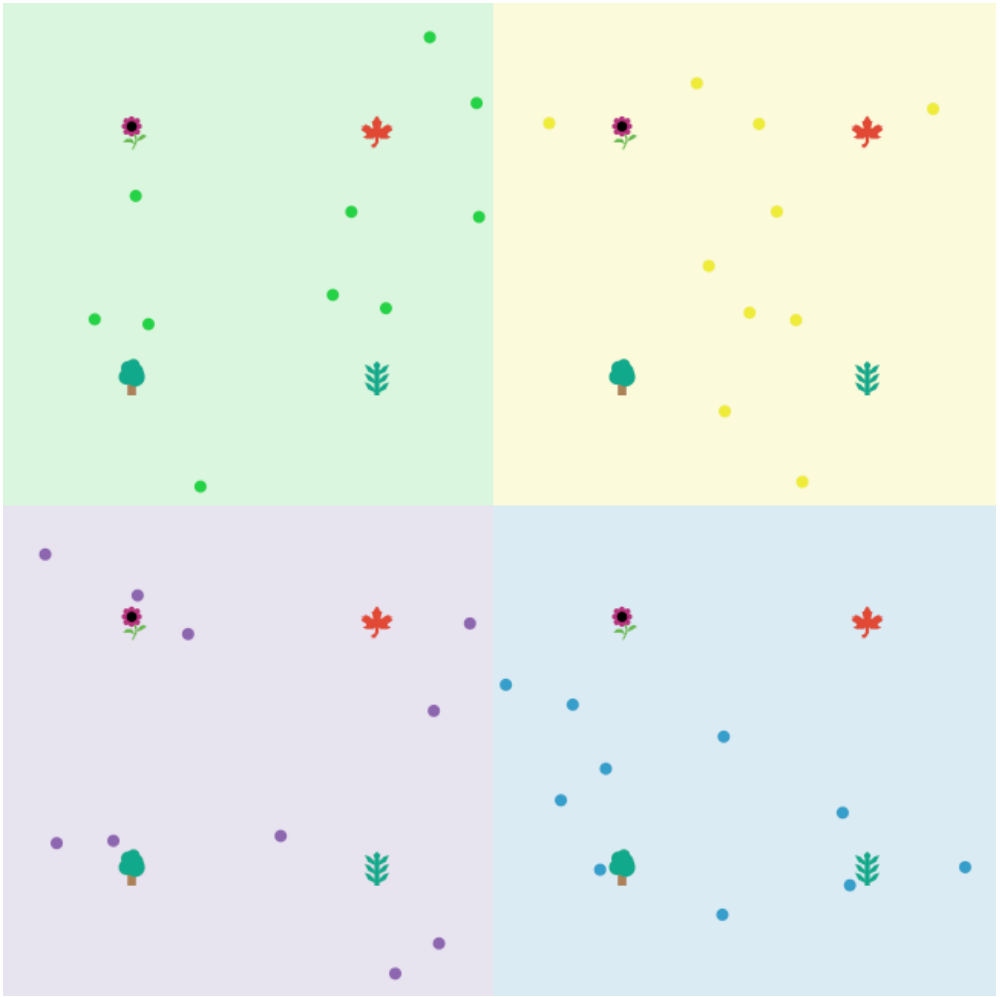
General Objective

To develop a multi-agent simulation model to study the influence of the spatial configuration on the emergence of a shared lexicon maintained by a group of distributed agents over time.



By spatial configuration we mean that agents have the ability of movement through out a two-dimensional space where there are placed different objects they can see and can talk about with other agents in recurrent interactions.

The Model: Landscape



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The Model: Learning Mechanism

Previous research in the area (Vogt and Coumans 2003) has identified three basic types of Language Games:

✓ **The Observational Game**

The Guessing Game

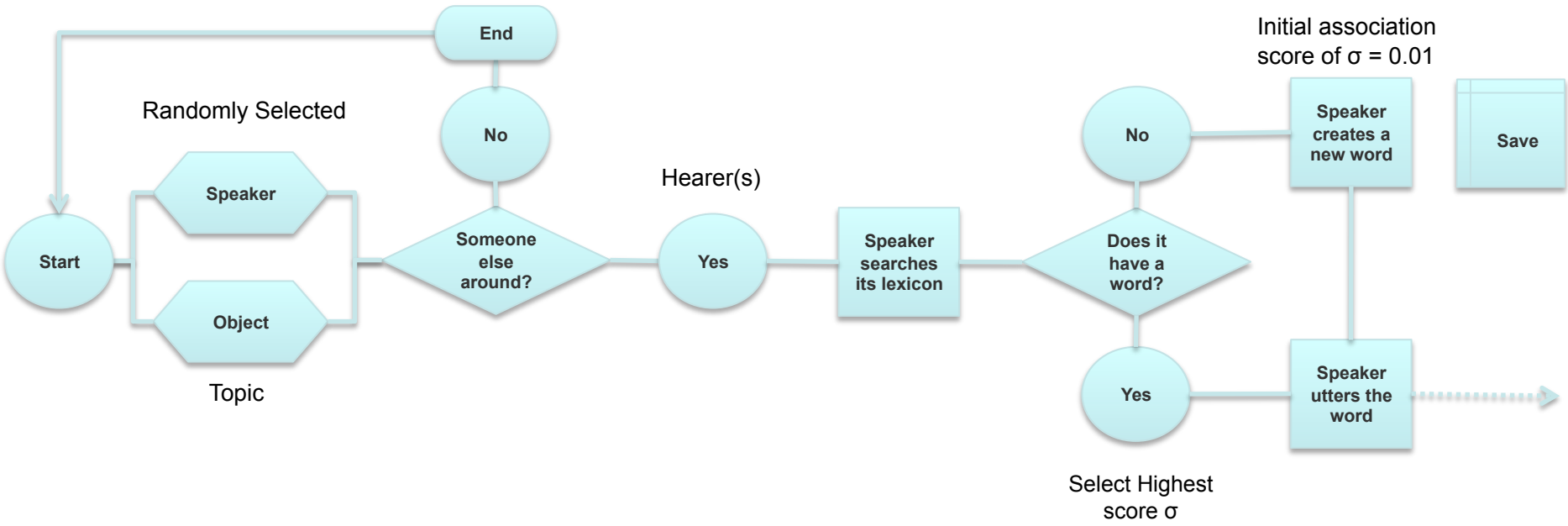
Same Performance

The Selfish Game

Low Performance

The Model: The Observational Game (Modified)

The observational game uses joint attention to enable associative Hebbian learning. The game is organised as follows:



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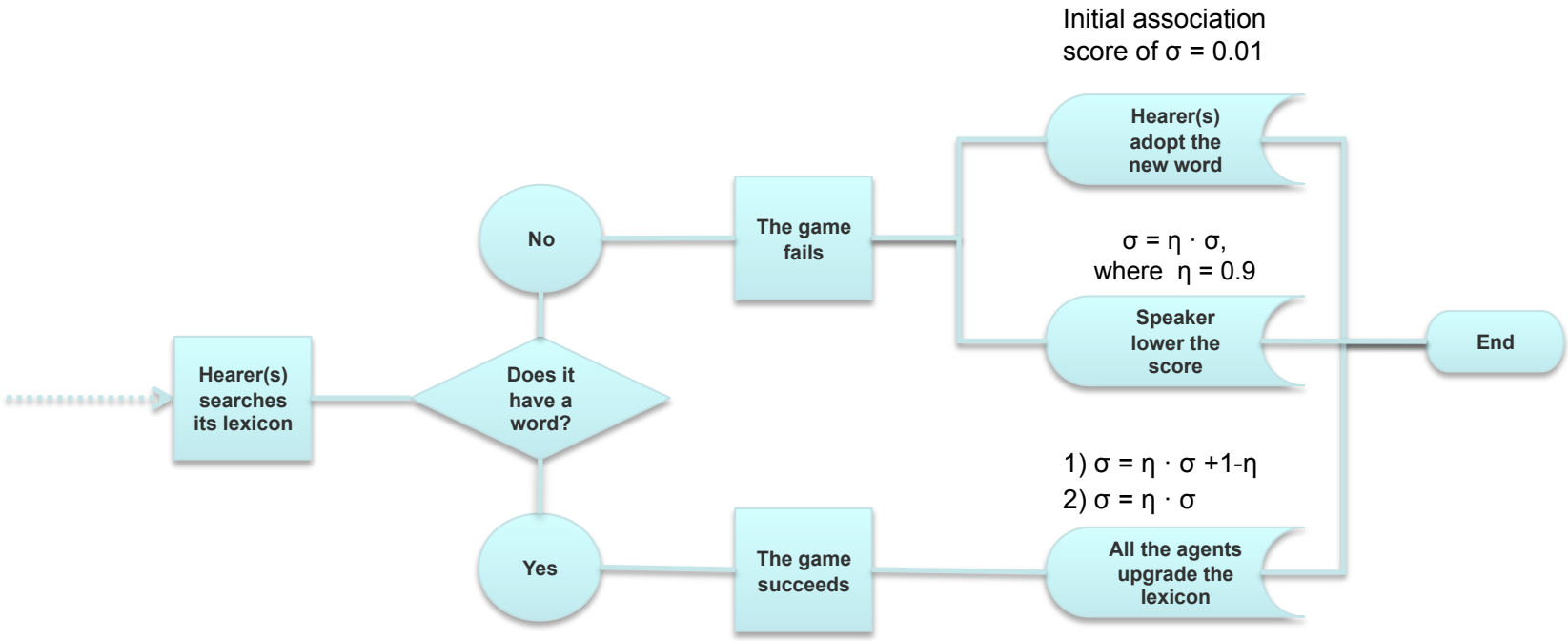
The Model: The Observational Game (Modified)

The observational game uses joint attention to enable associative Hebbian learning. The game is organised as follows:



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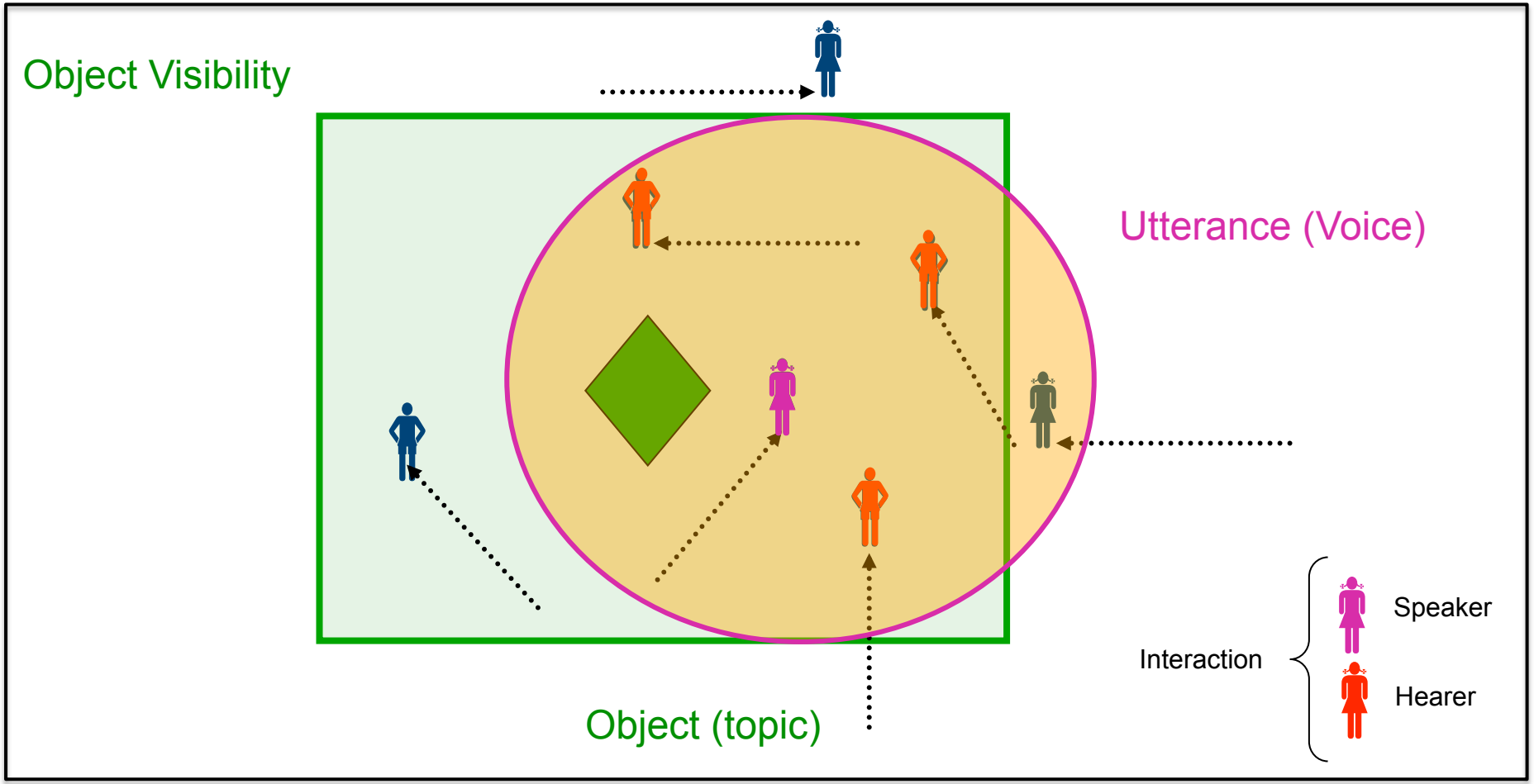
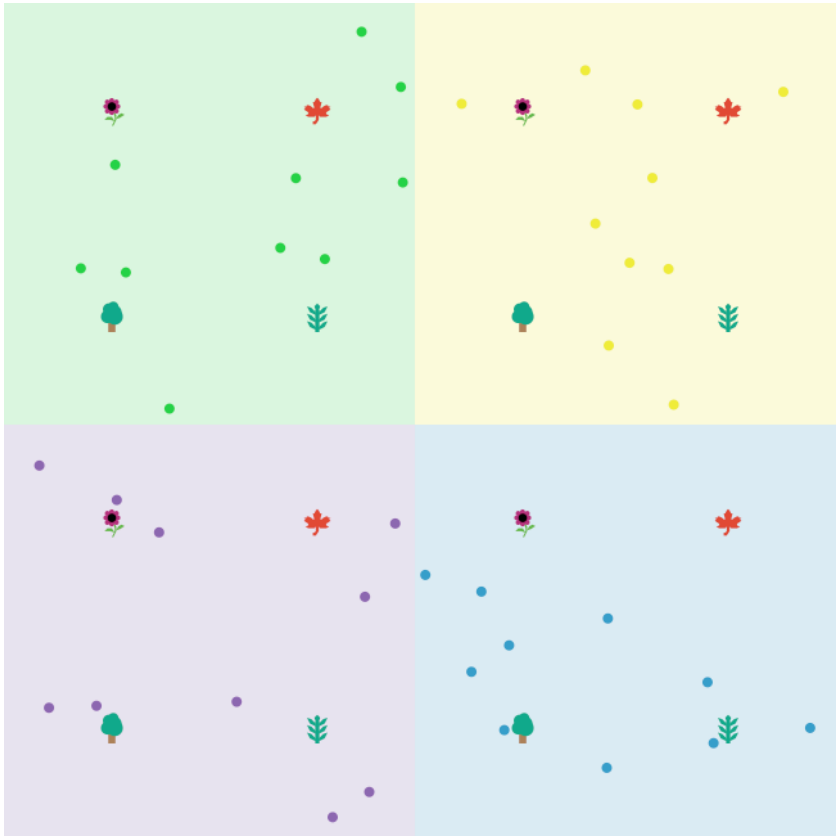
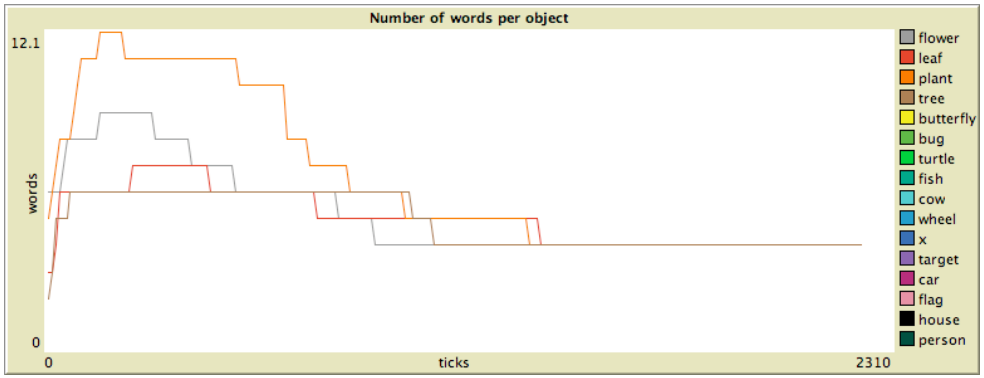
The Model: Spatial Dynamic



Results

Results: Space with Boundaries





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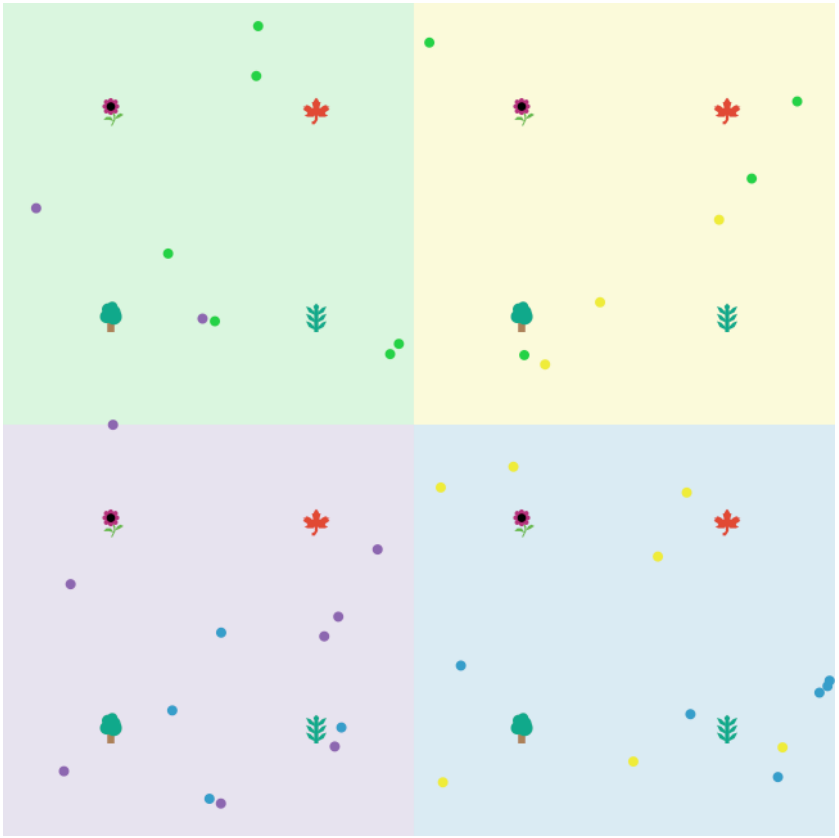
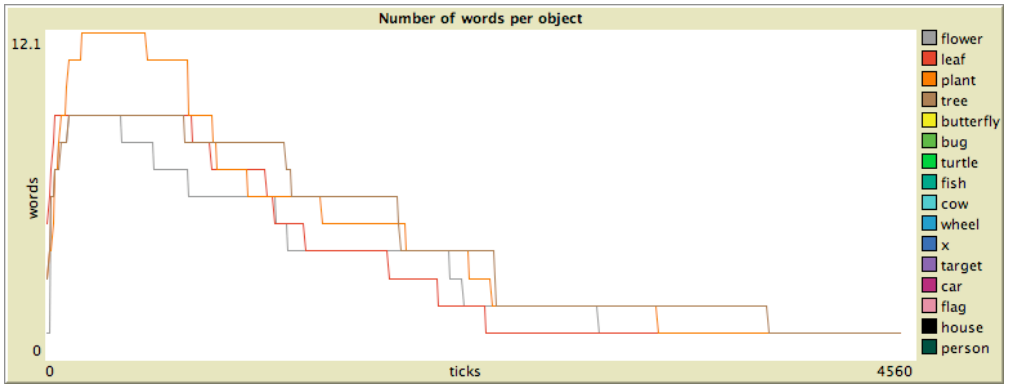
Results: Space with No Boundaries





GLOBAL LEXICON

["flower" "yjow"]

["leaf" "gkeb"]

["plant" "ycuw"]

["tree" "gbaz"]

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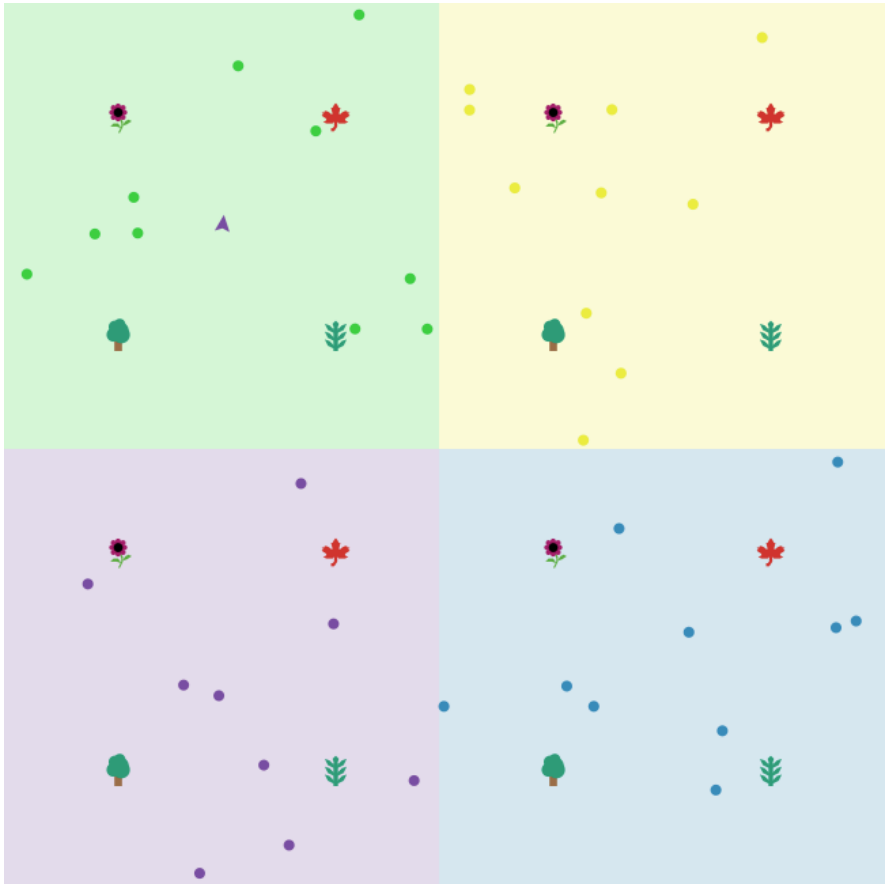
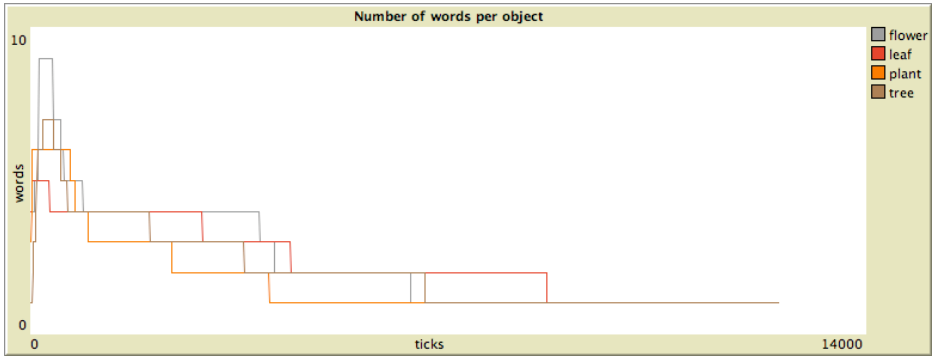
Results: One Deaf Explorer





GLOBAL LEXICON

["flower" "vzol”]

["leaf" "vfaj”]

["plant" "vrof”]

["tree" "vkom”]

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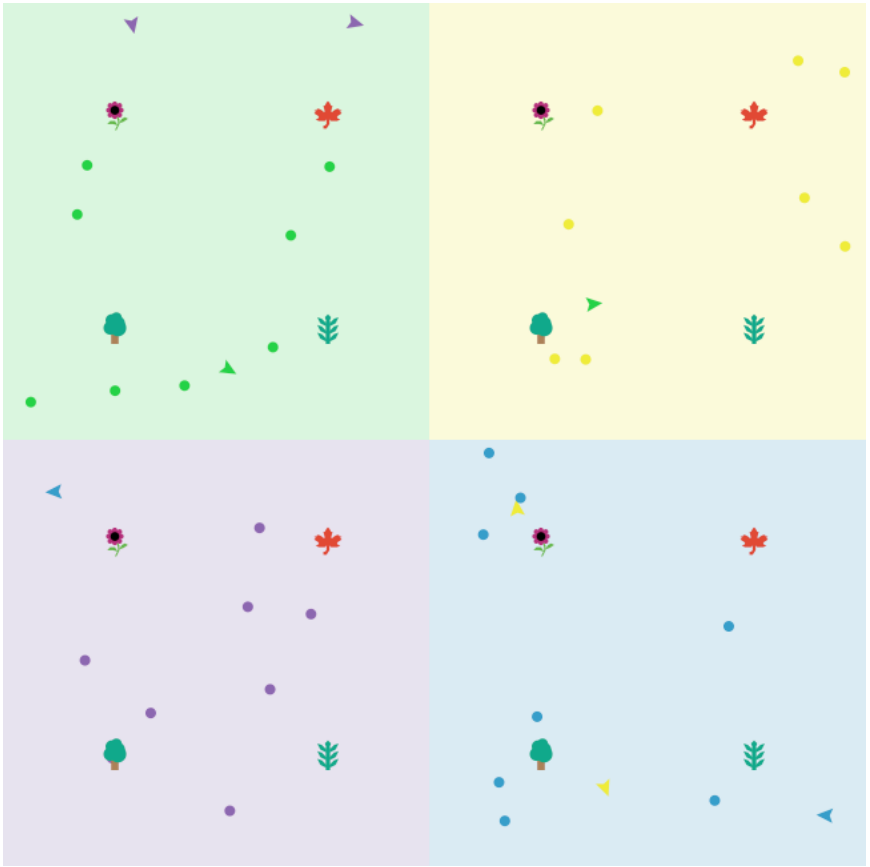
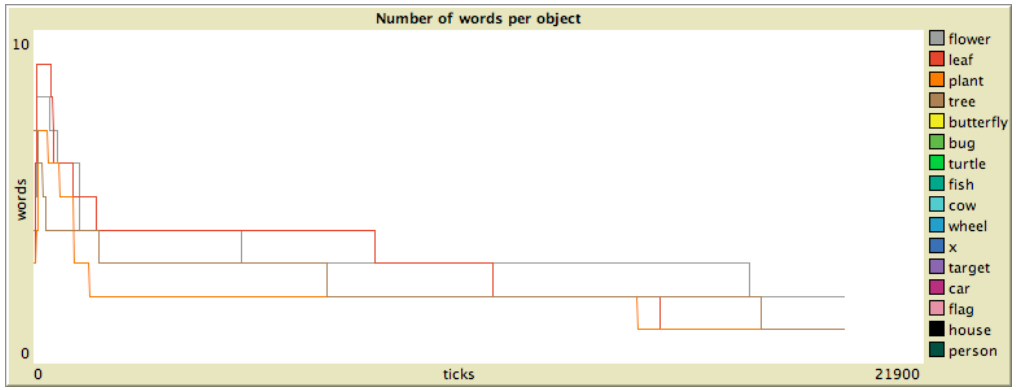
Results: Space with Two Explorers





GLOBAL LEXICON

[["flower" "yfux"] ["flower" "bxet"]]

["leaf" "yvog"]

["plant" "vsez"]

["tree" "gfej"]

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Results: A Question...

GLOBAL LEXICON

[["flower" "yfux"] ["flower" "bxet"]]

["leaf" "yvog"]

["plant" "vsez"]

["tree" "gfej"]

Can we identify any agent behaviours that increase the likelihood to spread a lexicon coming from a single region?

Results: An Answer...

Hypothesis

Lexicon from Noise: Emergent lexicons in a multi-agent spatial configuration

Thesis

Speaking laud and moving slow are the best agent settings to increase the likelihood to spread the lexicon coming from its own region

Proof

a) Design an appropriate experimental set

b) Run many simulations for each experimental set

c) Perform statistical tests to measure the significance of the simulation results

Results: An Answer...

Experimental Set

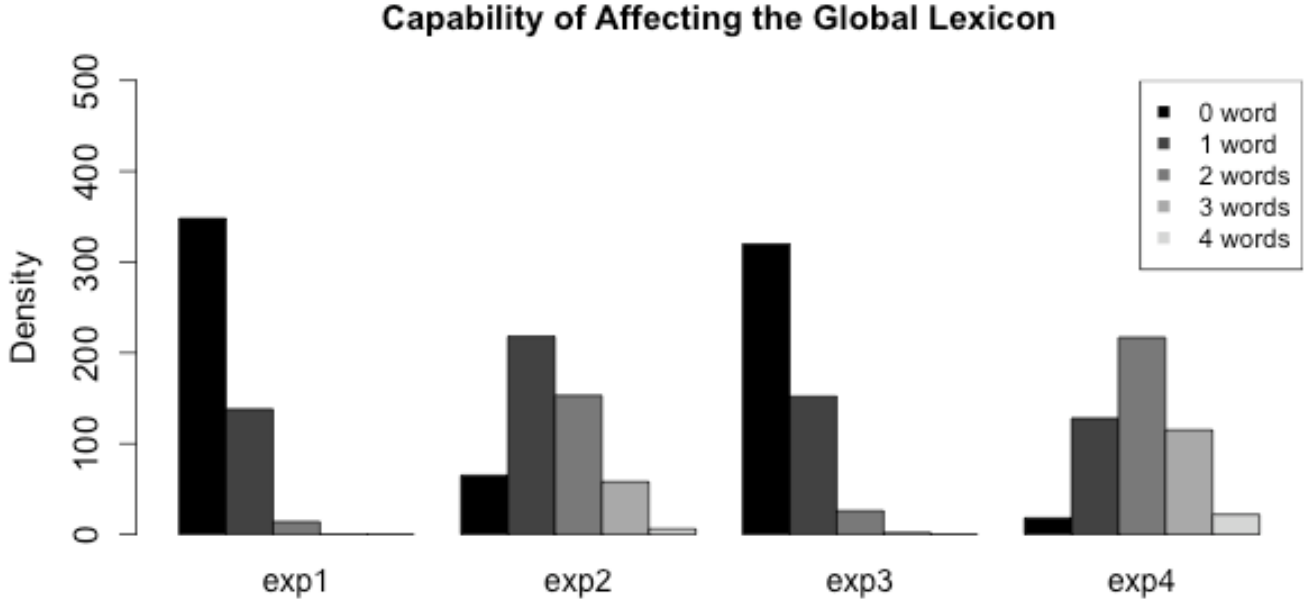
a) We design four different experimental sets and they have been run for five hundred times each

b) For three regions we set the same audibility radius and step length values and just for one region we set different values, either higher or lower

c) Three regions have audibility radius equals to 13 and step length equals to 0.7. The last region varies those parameters as shown in the table bellow:

	Audibility Radius	Step Length
Experiment 1	10	1
Experiment 2	16	1
Experiment 3	10	0.4
Experiment 4	16	0.4

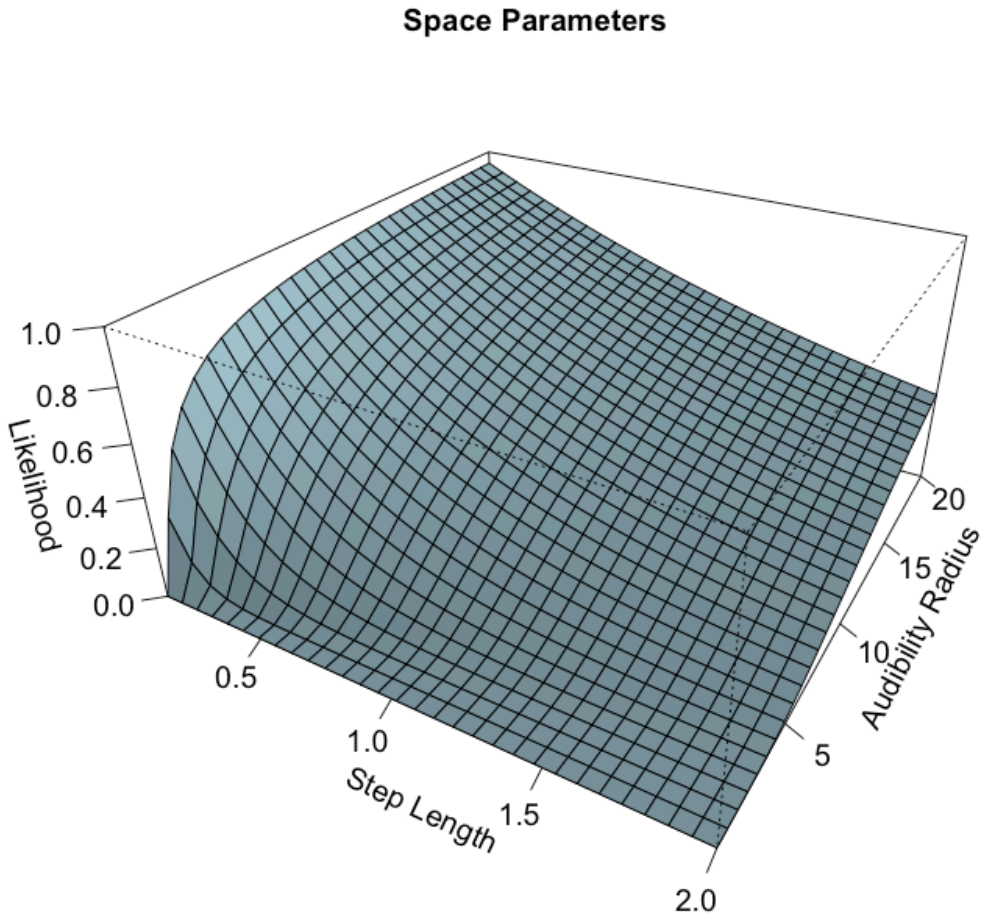
Results: An Answer...



Number of Words in the Global Lexicon per Experiment
(ar = audibility radius; sl = step length)

	t-statistic	p-value	confidence interval		mean difference
exp1 vs. exp2	−23.8074	≤ 0	−1.2036	− 1.0203	−1.112
exp1 vs. exp3	−2.4394	0.0148	−0.1587	− 0.0172	−0.087
exp1 vs. exp4	−35.5782	≤ 0	−1.7494	− 1.5665	−1.658
exp2 vs. exp3	21.0356	≤ 0	0.9284	1.1195	1.024
exp2 vs. exp4	−9.5922	≤ 0	−0.6576	− 0.4343	−0.546
exp3 vs. exp4	−32.3198	≤ 0	−1.6653	− 1.4746	−1.57

Results: An Answer...



Generalizations

To find some social behaviours related to our model results

- By saying audibility radius we mean the capability of reaching audience
- By saying step length we mean the frequency of changing the topic
- By saying lexicon we mean information
- So…
  - Political speech (speak laud and move slow)
  - TV News (speak laud and move fast)
  - Blogs (speak low and move slow)
  - Mouth to mouth (speak low and move fast)

Discussion

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