Simulation methodologies for decisions-making support on linguistic policies

Piero Ausonio Bianco
Kinthales – Associazione dei Sardi in Torino
<pabianco@tin.it>

Abstract

The success of any decision made in the domain of political sciences is conditioned by a set of interacting factors, so that the prevision of the final result turns out quite difficult. Regarding the domain of social sciences, new methodologies of modelation and simulation have recently been proposed (the agent-based modelation), which can be used also in the linguistic domain in order to help the political decider with the choice of efficient linguistic actions.

This article presents the theoretical frame, in which the agent-based modelation (ABM) can be developed. By using developing SW ambiences applied to the domain of political simulation the first results simulating the behaviour of a real linguistic community are presented, so that we can confirm both the complexity of the problem and its validity as a supporting instrument for political decisions.

Keywords: Simulation, ABM (Agent based modelling), Multi-agent modelling, Linguistic policies, Methodological Individualism.

1 The Big problem in less commonly spoken languages. What tools to avoid their death?

It's certainly common sense to affirm that a significant numbers of languages will disappear in the near future.[1] In a situation where two or more languages are used, one of which is the official national language and the others are the languages of native populations, native language will easily be abandoned.

The fundamental cause for the disappearance of a human language is obvious: speakers abandon their native tongue when its use become disadvantageous.

[1] At least 20%, and perhaps as many as 50% —of the world's 5000 to 6000 languages are already moribund, i.e., no longer spoken by children. See also «Manifesto» of Foundation for Endangered Languages: <http://www.ogmios.org/manifesto.htm>

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But a more complex question is: «Why, and when, a community's language become less efficient and gets discarded, in favor of another, preeminent language?»

A sufficient answer involves outlining an intricate matrix of variables dealing with community culture, self-identity, its relationship with other groups, degree of political autonomy, in other words, a complex set of phenomena that constitute the area of «ethnolinguistics».[2]

That's a non exhaustive list of possible topics, and it tends to be neglected when political and cultural leaders discuss language preservation.

Usual solutions for endangered languages are strategies of political protection, based, for example, on:

- imposing the use of minority languages in official communications;
- teaching of minority languages in all schools.

Related to those topics is the problem of the standardization of a spoken, but not written, language, often with many different local variants, without a rich literature, only used in specific contexts (it's obvious: although it is technically possible, nobody has ever written about nuclear physics in «sassarese» SDC,[3] the traditional language of the Sassari, in Sardinia, where I was born).

To achieve this goal, linguistic expertise is required, and then many linguistic brains discuss about the definition of a «standardized language», which seems like a mélange of every local variant.

But if I don't use the minority language because its use is disadvantageous for me, how could the use of new, strange, and often hard to learn variant of this language (the «standardized language») reduce the risk of language loss?

In conclusion: is the strategy of political protection useful?[4]

In my opinion, sometimes an authoritarian idea underlies this strategy: «I, the political planner, order what languages are to be spoken by my subjects. All my orders will be accepted without discussion and will became reality.»

[2]We prefer to speak of «ethnolinguistics», instead of «sociolinguistics», that studies linguistic variability in regard to social stratification (links between linguistic facts and social variables), while ethnolinguistic deals with links between language(s) and society/ies. See G. Berruto, *Fondamenti di sociolinguistica*, Roma & Bari, Laterza, 1994 (pp. 14-15) and G.R. Cardona, *Introduzione all'etnolinguistica*, Bologna, Il Mulino, 1976.

[3]For every language cited, the Ethnologue language code has been adopted. See `<http://www.ethnologue.com/family_index.asp>`, for a brief, and often not up-to-date description of world languages.

[4]A review of the legislative framework for protection of Italian linguistic minorities is provided in M. Stolfo, «Un primo passo verso l'Europa. Radici storiche, problemi e prospettive di attuazione della legge italiana di tutela delle minoranze linguistiche,» *Ianua. Revista Philologica Romanica*, vol. 3 (2002), pp. 131-155 [also in <http://www.romaniaminor.net/ianua/>].

Other contributions by different scholars in the monographic issue: Vincenzo Orioles [a cura di], *La legislazione nazionale sulle minoranze linguistiche. Problemi, applicazioni prospettive.* In ricordo di Giuseppe Francescato, Atti del Convegno di Studi Udine 30 nov.–1 dic. 2001 [*Plurilinguismo. Contatti di lingue e di culture* vol. 9 (2002)]. An analysis of European Community legislative acts on national minorities protection is: F. Benoît Rohmer, *Les minorités, quels droits?*, Éditions du Conseil de l'Europe, 1999.

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But are we sure that people will thus reverse their ideas about the disadvantages of native language?

Additionally: are we sure that imposition by law is truly able to contrast the danger of language loss?

That's a very good question, and the answer is very hard to find. We have to predict the future of a minority language!

2 An «organizational» point of view

In every social structure (from a family, to an industrial factory, to a State) it's possible to find:

- *people*;
- *structure* (elements that order and link different organization elements, like rules, laws, formal or informal influence);
- *emergence*: a collective organization which arises out of the complex processes emerging from repeated interactions among people and between people and structure over time.

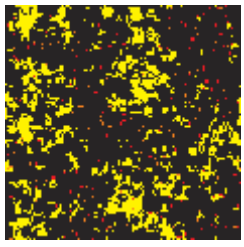
If I put together people with well know personalities, in a predefined structure, can I foresee the resulting emergence?[5]

[5]As an example, let us consider the computer simulation «Termites»: a pool of «e-termites» have to gather «e-wood» chips into piles. To do this, the termites have to follow a set of simple rules. Each termite starts wandering randomly. If it bumps into a wood chip, it picks the chip up, and continues to wander randomly. When it bumps into another wood chip, it finds a nearby empty space and puts its wood chip down. With these simple rules, the wood chips eventually end up in a single pile.

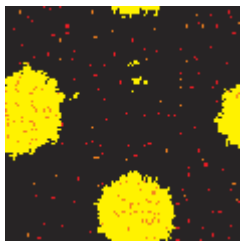
As piles of wood chips begin to form, the piles are not «protected» in any way. That is, termites sometimes take chips away from existing piles. That strategy might seem counterproductive. But if the piles were «protected», you would end up with lots of little piles rather than a single big one.

In general, the number of piles decreases with time. Why? Some piles disappear, when termites carry away all of the chips. And there is no way to start a new pile from scratch, since termites always put their wood chips near other wood chips. So the number of piles must decrease over time. The only way a «new» pile starts is when an existing pile splits into two. [Starlogo simulation: `<http://education.mit.edu/starlogo/samples/termites.htm>`]

Initial condition



Final state



A very good introduction to this new promising area of research, between human and natural sciences, is: S. Johnson, *Emergence, The Connected Lives of Ants, Brains, Cities, and*

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Social scientists frequently express skepticism about the possibility of making social predictions, for two main raisons: the inherent difficult of producing credible forecasts and the possibility that the forecast itself will affect the outcome.

Both topics are well illustrated by the famous Club of Rome simulations about the future of the world economy; those very bad predictions of an imminent (at the end of last century) global environmental catastrophe were not only based on assumptions with rather scant evidence, but also used inappropriate mathematical methodologies (linear modeling, standard statistical techniques).[6]

The real word is much more complicated; it's a «complex» world that exhibits chaos effects, fractal patterns, auto catalysis, different evolutionary patterns, catastrophic changes, local maxima confused with global ones, interrelations of changes, basin of attraction, and so on.

I used a lot of words typical of «complexity studies», i.e. the study of complex adaptive systems like human societies.

3 People stories

Bachisio: «I was born in a poor family, in a little village of inner Sardinia. My father knew only *Nuorese* [a local variant of SRD spoken in central Sardinia], but he used to talk to me in bad Italian, because he decided that, for his son, it would be better to know only the language of *studiati* [an incorrect use of a past participle to indicate 'those who know']. But I think my father was in right. I won't teach the Sardinian language to my children. It's for uneducated fellows. I hope my son won't be a workman like I am.»

Laura: «I'm a teacher, born in a family of University Professors and managers. My brother is a well know scholar in Italian Studies. I didn't learn the Sardinian language from my family. But now I'm trying to speak in *Sardo* [SRD] because I think that the Sardinian identity must adopt its own language. Do you think I agree with Lega Nord party and with its idea about federalism and northern Italian regional identity? Oh no! I'm an activist of an extreme leftist party.

»I think that every people must adopt its own language, at least in official acts. In Sardinia we don't have a uniform language? No problem! A uniform language must be defined, by linguistic scholars, and adopted all over the island.»

Barore: «The world is getting crazier and crazier! They [that means "the political powers that be", but with a taste of Moloch] tell me that in the future I must not speak *is campidanesus* [SRO],[7] my mother language, but a new *Sardo*, the LSU,[8] similar to that spoken in the Northern side of Sardinia. What will happen to me if I won't speak my language? Will the police put me in jail? Will

Software, Penguin, 2001.

[6]But those very bad predictions compelled political and industrial powers in thorough studies about, for example, the ecological impacts of human activities, patterns of development, new sources of energy.

[7]Variant of Sardinian language spoken in the Southern side of the island.

[8]LSU = Lingua Sarda Unificata 'Standardized Sardinian Language.'

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I leave my job in a town government office?»

What will happen when persons like these interact?

Probably, Bachisio will change his opinion in contact with the intellectual Laura, unless he gets the impression that speaking *Sardo* is a sign of leftist membership. Barore will regret every effort of the Sardinian government to preserve the Sardinian language through the definition of LSU (Lingua Sarda Unificata 'Standardized Sardinian Language'); he probably never met Laura![9]

4 Simulation as a way to make social experiments

Of course, we can't generate an experiment in which people can interact together, to see if the traditional language will survive or not, or to observe the —admittedly unlikely— success of LSU.

Agent Based Simulation can be an answer.[10] In a simulation, we'll build an «artificial society» with characters behaving similarly to the real ones they are modeled after, and an arena in which our silica Sardos (to tell the truth, the inhabitants of Sardinia are famous for their hard head...) will interact each other, following interaction rules to be defined.

The steps are as follows:

A. define *agents*: classes of people with the same character (both linguistic attitude and social status affecting ethnolinguistic vitality);

B. define an *arena* to represent the anisotropy of agent distribution and local opportunities/constraints;

C. define a formal set of interaction rules;

D. perform a simulation of agents in the arena;

E. study the statistical distributions of derived linguistic identities.

4.1 A Framework for bottom-up modeling of a linguistic community

Our path will move in the direction from individual behavior to collective actions.

First of all, we have to build a model (steps A, B and C) for «language vitality» investigation.

The question is more complex than it would appear at first: to know a language doesn't necessary mean to use it with other people. There are many examples of well known or protected or full visible languages that are not currently used in everyday life:

[9] Of course, Laura won't change her opinions! She (thinks she) is always in right!

[10] Agent Based Modelling (ABM) is one of the most promising methodologies to be applied to social sciences. For a complete review of simulation techniques: N. Gilbert, K. G. Troitzsch *Simulation for the Social Scientist*, Open University Press, 1999; D. Parisi, *Simulazioni: La realtà rifatta nel computer*, Bologna, Il Mulino, 2001.

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- the French [FRN] in Valle d'Aosta, enjoying Official Language status, is present in the media and in regional government documents, is taught in schools of all levels just as Italian [ITN] is, but isn't spoken at all,[11] in contrast with Italian [ITN] and Francoprovenzale [FRA], currently used for communication purposes;

- Occitan [PRV], spoken in France, Piedmont (Italy) and Spain (Val d'Aran);[12] its use in the Occitan valleys in Piedmont is wider than in France even though it is taught in French, but not in Italian, schools;[13]

- in an extra-European context, the Standard Shaba Swahili [SWA], a more prestigious variant of Swahili sub-dialects, widespread in Zaire's schools, churches and media, but less spoken than Shaba Swahili.[14]

To allow a complete description on an actual ethnolinguistic situation, there are many proposed points of view. In the following, we follow a suggestion by J. Edwards[15] for building a framework for the typology of minority languages.

The basic premise of Edward's framework is that the plethora of variables which are relevant to minority —language situations can be grouped in two categories:

- *perspective* by which human groups are to be characterized;

- *scope* over which perspective are to be applied; remembering elements present in every organization (see §2), scopes can be grouped into (following our terminology):

  – *people*,[16] i.e. basic agents, whose language choices influence only their neighbors, but is influenced by neighbors in turn, and «influential

[11] French is «importante, nella sua pesante assenza effettiva, in termini di conoscenza spendibile in senso di conoscenza spendibile in senso ideologico e di garanzia dell'identità culturale e di gruppo valdostana [...] l'élite politica locale porta a fondare e motivare la promozione del francese su una sua presunta effettività vitalità negli usi comunicativi valdostani, anziché sull'importanza in sé del valorizzare una francofonia sì fortemente appoggiata sul passato ma essenzialmente rivolta al futuro.» (G. Berruto, «Una Valle d'Aosta, tante Valli d'Aosta? Considerazioni sulle dimensioni del plurilinguismo in una comunità regionale,» in *Une Vallée d'Aoste Bilingue dans une Europe plurilingue*, Aoste, Fondation Émile Chanoux , 2003). The article was written for the presentation meeting of a large sociolinguistic survey in Valle d'Aosta, whose results are presented in <http://www.fondchanoux.org>.

[12] News in Ethnologue sites isn't correct, at least for Piedmont linguistic awareness, that denominate Occitan the Provençal [PRV] language.

[13] Gianpiero Boschero (president of Soulestrelh, Sampeyre (CN) Italy), personal communication (5-25-2002). Same consideration in *Unesco Red book on Endangered languages*: <http://www.helsinki.fi/%7Etasalmin/europe_ report.html>.

[14] A. Kapanga «Impact of language variation and accommodation theory on language maintenance: an analysis of Shaba Swahili» in L. A. Grenoble and L. J. Whaley (ed.), *Endangered Languages*, Cambridge University press, 1998, pp 261-288.

[15] John Edwards, *Sociopolitical aspects of language maintenance and loss; towards a typology of minority language situations*, cit. in L. A. Grenoble and L. J. Whaley (ed.), *Endangered Languages*, Cambridge University press, 1998, pp 24-28.

[16] *Speakers* in Edward's terminology.

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agents» such as political and intellectual agents; their influence uses «tools» like legislative acts and media, to change the structure;

– *structure*,[17] i.e. actions (either formal or informal) conducted by «influential agents», such as policy makers (local leaders and political parties), intellectual leaders, Government; they differ from basic agents in being «immutable», i.e. not influenced by other agents' behavior. Structure also includes natural ties, which regulate or influence community life, such as the distance between communities or borders (in a simulation, these elements influence the «arena» in which the simulation acts);

– *output*: languages used as a result of interactions among agents and between agents and structure (in ABM terms: *emergence*).

Perspective and scopes are arranged as follows:

Table 1

Perspective	**Scope**		
	People	**Output**	**Structure**
Demography	1	2	3
Sociology	4	5	6
Linguistics	7	8	9
Psychology	10	11	12
History	13	14	15
Political	16	17	18
Geography	19	20	21
Education	22	23	24
Religion	25	26	27
Economics	28	29	30
Technology	31	32	33

To build a model, Edwards (with some additions by the author) proposes a set of sample questions; the answers are the «interaction rules» among «agents» and between agents and arena.

[17] «Setting» in Edward's terminology, i.e. features of the broader context in which a defined community is located.

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TABLE 2: *People point of view.*

		Question	**Explanation: Possible Interaction rules**
1	Demography	Numbers and concentration of speakers?	In a conversation between more than two people, language spoken is majority language known —in formal language: If each person has a probability Pi(age) to speak a mL, the probability that the conversation will be in a mL is $P(age_1) \cap P(age_2)$.
		Use of ML or mL depending on age?	Interaction majority rule uses a: P_I(age) modified with agents' age.
4	Sociology	Socioeconomic status of speakers?	Interaction majority rule uses a: P_I(status) modified with agents' social class.
7	Linguistic	How many Languages are known?	Repertoires of known languages that can be used in a conversation between two or more people. Preference of principal language (between languages known).
		Linguistic capabilities of speakers?	Interaction majority rule uses a: P_I(lan-cap) modified with agents' language capability, that take into account enforcement of a language knowledge for its increasing use (the more a language is used, the more its weight increases).
10	Psychology	Gratification in use of mL	Gratification can be related to language relevance in conversation (minimum in utilitarian conversation, when use of mL or ML depending on typology of conversation —familiar utterance...). Can be simulated by ranking preference on using a languages present in repertoire previous defined (7).

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			Preferences can wide vary according, for example, from convenience in conversation (only a utility choice), to group identity marking (cultural choice).
13	History	Personal history of each agent.	Each interaction step takes into account the previous situation (like the actors' disposition in the arena).
.		How did previous utteranced end up?	Rank modification depending on successful end of utterance.
16	Political	Rights and recognition of speakers?	Modification of rank depending on power status of agents. (Presence of agents who have to speak (in defined domains) only the official language (not only ML, but also mL, if there's political support for the mL).
19	Geography	mL diffusion? Local variations of mL?	Ease in moving of agents.
22	Education	Speaker's attitudes and involvement regarding education? Political support for mL revival?	Change of rank (10) depending on education.
25	Religion	Religion of speakers?	Influence of the religious domain in people life (i.e. probability of contacts with religious influential agents).
28	Economics	Economic health of the speaker group?	Types of economic transaction: usefulness of mL in economic transactions* can change the rank of language preference.
31	Technology	Group representation in the media? Access to media?	Access of people to media listened in ML and mL.

mL = minority language

ML = majority language

* An interesting study on linguistic impact on trade is: W. K. Hutchinson «Linguistic Distance as a Determinant of Bilateral Trade», Working Paper No. 01-W30 (December 2001), Department of Economics, Vanderbilt University, Nashville; <http://www.vanderbilt.edu/Econ/wparchive/workpaper/vu01-w30R.pdf>.

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TABLE 3: *Structure point of view.*

		Question	**Arena features: Possible Interaction rules**
3	Demography	Rural-urban nature of the setting?	Distribution of similar agents in arena. Sub-arenas with boundaries from close to fully open (time anisotropy variations).
6	Sociology	Nature of previous/current maintenance and revival efforts?	Influence modes of influential agents: soft or hard power?
9	Linguistic	Nature of in- and out-migration?	Influence on languages choice by topics like the introduction of a standardized mL.
		Linguistic Standardization?	Shifting in the arena of language speaking groups (stochastic move or forced migrations by government).
12	Psychology	Attitudes of the majority group towards minority?	«Aura» related to influential agents. For example: I have to use L with government agents, but, if I dislike government or I haven't any other advantage in using L,* probably I'll also dislike L.
15	History	History of the area in which the group now lives?	Initial rank (7) at start of simulation ($t = 0$), that can take into account soft or hard introduction of ML in a historical mL area.
		History and background of the group?	
18	Political	Degree of autonomy or «special status» of the area?	Support for mL, simulated as «Influential agents» action range. Definition of specific interaction domains that avoid or forbid use of a definite language.

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21	Geography	Protection of mL local variants?	Relative density of similar agents. Geographical diffusion of mL: Anisotropy of agents' preference (rank) and tipology in the space, due to: – Dispersion of agents into the arena. – Cluster of similar agents.
24	Education	State of education in the area? mL in education programs?	Support for mL in schools (i.e. presence of agents that influence only young people).
27	Religion	Importance of religion in the area?	Use of a mL in religious domains (scripture, liturgy, Homily, music, prayer, announcements).
30	Economics	Economic health of the region?	
33	Technology	General public awareness of area? Presence of mL in media?	The presence of mL in media can vary the influence of mL agents (political agents, intellectuals).

mL = minority language

ML = majority language

* As French in Valle d'Aosta, see before.

4.2 Language vitality

At this point, we have our simulation rules. To evaluate language use evolution (i.e. maintenance of, or shift from, the traditional language), we have to use indicators to observe and quantify the effects of different linguistic policies.[18]

Among symptoms of language death proposed by sociolinguistics, we consider applicable for our purpose, mainly for their completeness in classifying language

[18] And then, the achievement of language policies' goals. In my opinion, sometimes politicians make a lot of fuss, badly defining scopes and objectives on minority language protection. In my experience, I heard from intellectuals and politicians goals like:

- to mark group identity;
- to protect language as a cultural heritage;
- to increase people's welfare (in particular elderly people);
- to preserve links between groups;
- to support a language in new domains of use.

Could this fussy agent-based modelling methodology help political decision makers to better define their objectives?

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vitality, the following ethnolinguistic indicators:[19]

- Relative position on the urban-rural continuum: a language that is remote from an urban community or congregation of other-language speakers would be the least affected, therefore the strongest. Then, we have to investigate whether:
  - the speech community is located in or near a population center where its members would have contact with speakers of other languages;
  - they have access to such a population center.
- Domains in which the language is used: the more domains in which the vernacular is used, the better. Anecdotal evidence suggested that the last domain to be lost in any potential language allegiance battle is that of the home. Thus, the home forms the anchor domain for this hierarchy. Then, the question is whether there is sufficient use of the mL throughout community life.
- Frequency and type of code switching: code switching within the multilingual context occurs when speakers use forms from one language (called the embedded language) in an utterance that is primarily composed of another language (called the matrix language) within the same conversation. A steady-state (bilinguism - diglossia) is represented by conscious switch depending on situation, while a threatened minority language situation occurs when switching between mL and one or more different languages occurs without any notable consistency or when there are frequent individual unbounded code switches.
- Population and group dynamics: one of the most commonly cited factors in the determination of potential viability is the matter of a critical (how much?) mass of speakers; but another point to be investigated is the stress that occurs when immigrants came to live among the mL community.[20]
- Distribution of speakers within their own social networks; dense multilink networks with uniform distribution of mL speakers are good for the maintenance of a mL within a wider societal context.
- Social outlook regarding and within the speech community; this indicator relates language to ethnic identity. As language choice can serve as a marker of ethnic identity, so a strong ethnic identity can influence language

[19]M. Lynn Landweer (2000): «Indicators of Ethnolinguistic Vitality.» *Notes on Sociolinguistics* 5(1):5-22 [also in <http://www.sil.org/sociolx/ndg-lg-indicators.html>].

[20]This event is considered beneficial in Catalonia:, evenf if local mL (Catalan [CLN]) is strongly promoted by local government (Generalitat de Catalunya), people continue to prefer statal Spanish [SPN]; then local government relies on immigrants from Maghreb to reach the threshold of 50%, considered the minimun for language vitality (immigrants are indifferent in learning one or other language!) (Francesc González i Planas, Romania Minor; private communication).

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choice. If we can model ethnic identity, then it's possible to see if there's internal and/or external recognition of the language community as separate and unique within the broader society. The greater the positive internal identity, external status, and cultural distinctions the better is the support of the mL.

- Language prestige: a descending scale of relative prestige could be from a nationally recognized language having the greatest prestige and thus a greater potential for use in the foreseeable future, and locally disparaged varieties having the least potential for continued use in the future (assuming other supports are also absent). Then the questions asked are: Does the target language have prestige among other neighboring or regional languages? What is the relative prestige of the language within the linguistic repertoire of the speech community?

- Access to a stable and acceptable economic base: if the ML is thought economically beneficial by mL community, shift in language allegiance will be a consequence which hinges on the parents' perception that adequate work environments using their mother tongue do not exist for their children. Hence, a topic to be investigated is whether there is an acceptable economic base supportive of continuing use of the mL language, or its use implies economic disadvantages.

Whether a language appears to be «maintained» or «dying» depends on the collective impact of positive or negative indicators that place the language on a continuum of stable vitality, change in process due to other-language interference, radical shift in process, and death. As such, language maintenance and shift are long-term consequences of consistent patterns of language choice throughout the speech community.

5 Experimental set-up

Once the model is defined, we have to perform steps D and E.

Today, many different computer tools to perform ABM (Agent based modelling) are proposed.

To show the possibility of ABM, I chose PS-I,[21] a platform developed by Ian S. Lustick[22] (University of Pennsylvania) and Vladimir Dergachev (University of Pennsylvania, now at University of Michigan). PS-I has been used to design templates for various social experiments on:[23]

[21] There are many other toolkits. At one side Starlogo and AgentSheets, user friendly, but can only be used to produce only simplified models as «termites». On the other side, SWARM, RePast, and ASCAPE, which in principle could be used to produce models of real experimental interest to social scientists, require users to be proficient in computer programming and high level language as Java.

[22] Web address of PS-I site is: `<http://www.psych.upenn.edu/sacsec/abir/private/about.htm>`.

[23] A popular introduction on Lustick's works is: Jeffrey Rothfeder, «Terror games,» *Popular Science* (march 2004).

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- Globalization of different kinds and intensities and its impact in relation to the relative porosity of state boundaries.
- Immigration and the propensity of states to produce populist anti-immigrant reaction.
- Regime repression vs. US diplomacy as techniques for protecting friendly Middle Eastern regimes against internal threats associated with Israeli-Palestinian violence.
- Vulnerability of authoritarian regimes to different kinds of ethnic or religious mobilizations.
- Prospects for the spread of a «European Identity» under conditions of increasing porosity of separate state boundaries in Europe.
- Effects on regime prospects and prospects for terrorist linked nuclear events in Pakistan of Muslim Fundamentalist mobilization in Pakistan under various conditions.
- Effects of regime responsiveness vs. repression and autonomy schemes on the likelihood of secessionism and secessionist movements among regionally concentrated ethno-political minorities.

Since this lecture is only a presentation of a (credible) methodology, I won't present the results of simulation studies, but demos based on a Lustick model developed to test the constructivist theory.[24]

Thus, only a limited set of interaction rules will be implemented.

Conducting experiments requires the production of templates designed to incorporate what is believed to be true about the attributes and dynamics of interaction within the political arena.

For minority language purpose, we have to model an «artificial world» characterized by:

[24] Actually, I plundered what was written by I. Lustick and adapted that to my purpose! Mainly, I used (all papers are at <http://www.psych.upenn.edu/abir/>):

- *User Manual for PS-I.*
- Ian S. Lustick *PS-I: a user friendly Agent-Based Modelling Platform for testing Theories of Political Identity and Political Stability* UCLA Center for Computational Social Science Conference, Lake Arrowhead, May 9-12, 2002.
- Ian. S. Lustick, Dan. Miodownik, Stanley S. Philbrick «The Institutionalization of Identity: Micro Adaptation, Macro Effects, and Collective Consequences», paper presented at the annual meeting of the American Political Science Association, August 2000, Washington, DC.

and,

- Ian Lustick (2000): «Agent-Based Modelling of collective identity: testing constructivist theory.» *JASSS Journal of Artificial Societies and Social Simulation* vol. 3(1) [<http://www.soc.surrey.ac.uk/JASSS/3/1/1.html>].

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- Types of agents, which can be:
  - Basic: ordinary people who can influence only their neighbors (see before); basic agents can be differentiated in:
    - basic ML agents (agents who know only the Majority language), can evolve into multilingual agents);
    - basic multilingual agents (agents who know different languages and who can shift among them during a conversation);
    - basic mL agents: able to speak only the minority language; depending on the situation, they can evolve into multilingual agents or remain unchanged (simulation of elderly people).
  - Influential agents, who control and manipulate the population of basic agents in the areas over which the network, or web, of such agents is spread. Such «authority structures» can be modeled as dense or lightly present, as hierarchical, pyramidal, or top heavy, as alienated from or responsive to the political identities and commitments of constituents, etc. They are characterized by a high influence level and immutable linguistic identity (they speak only a defined language, either mL or ML), and can be differentiated in:
    - Intellectuals either in mL or in ML.[25]
    - Politicians, either in mL or ML.
- *Arena*, i.e. spatial distribution of agents, which can be isotropic or anisotropic, in order to simulate complex social links or isolation of specific agents.

In agent-based modeling terms, the world is a two-dimensional space (generally a torus, to avoid border problems) inhabited by an array of square shaped agents.

Each agent interacts locally in each time period with agents in its «Moore neighborhoods» (the eight agents who touch it on its sides and corners), monitoring the language spoken by neighbors and shifting to a common language.[26] The agents can also be aware of the general attractiveness or unattractiveness of speaking any particular language, regardless of the identities displayed (activated) in their neighborhood. In this way, it is possible to simulate shifts in the

[25]Lustick, in «The institutionalization of identity...», verify Gramsci's statement on intellectual role.

Following another capital question by Gramsci: «Gli intellettuali sono un gruppo sociale autonomo e indipendente, oppure ogni gruppo sociale ha una sua propria categoria specializzata di intellettuali?» (incipit of «Prison's Notebook» q. XII) [Are intellectuals an autonomous and independent social group, or has every social group its own specialized category of intellectuals?], I suppose that every language has its own intellectuals, who work to preserve or spread the culture and language of their social group. Depending on links between politic identity and language, these intellectuals would be more or less similar to Gramsci's «rural intellectual» (vs. urban intellectuals). A personal news: I'm proud to be born about 100 km from Ales and Ghilarza where Antonio Gramsci was born and spent his youth.

[26]Thus each agent is endowed, as people and identities in constructivist theory, with a «repertoire» of languages, chosen in conversation not only for commodity use, but also to make a «presentations of self»: from marking cultural tracts like politeness, education and so on, until a political interest tracts like ethnic identity.

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cultural/political climate that could change the value of languages (like a minority language renaissance), arising from non local influences like mass media, education or legislative acts.

Locally, depending on patterns of language use, such changes at the general level might or might not result in changes in language use patterns among the individuals with whom he has contacts. If the individual's neighbors activate alternative languages, the complexion of the neighborhood could change, thereby changing the weight of pressures on him to activate on the language newly adopted or forsaken by his neighbors. Under extreme circumstances (soft or hard political constraints), this individual might even learn a new language into his repertoire, for example, a standardized minority language. In these artificial worlds, no aspect of collective organization or collective identity is present other than that which arises out of the complex processes emerging from repeated inter-agent interactions over time.

At the beginning of a «run» (which will be a «history» of the polity) the landscape can be «re-seeded», randomizing both the distribution of language known and used by all types of agents.

If it is left open as an empirical question the issue of how large one should imagine the «time steps» as being (linguistic transactions, days, months, years?), it's possible to suggest that at one time step this individual might use a mL, while subsequently he could use a ML.

As is asserted by Constructivist theory, all of these micro-adjustments cumulatively produce patterns then noticed at the macro level as collective linguistic identity.

PS-I implements these general rules in a systematic way. In each time step, each agent does a simple survey of language spoken in its neighborhood, combining that information with the negative, positive, or neutral biases associated with those languages at that time and with an awareness of the languages inside its own repertoire. Each agent then «decides» to maintain its currently language spoken, or use an alternative one from its own repertoire. Each agent thus acts independently.

By running the simulation with identical parameter settings many times, and then varying «bias» assignment over time, we get different runs (different simulated histories) from the same starting point.

To simulate different starting point («wold-be world»), we can vary parameter setting, as described in the «Technical Note».

In such ways, regularities in the distributions of collective outcomes can be examined and used to test the possible effects of intellectual and politicians decisions.

Valuable opportunities are thereby created for studying directly how outcomes at the macro level are linked to variation in different factors seen to be operating at the micro level.

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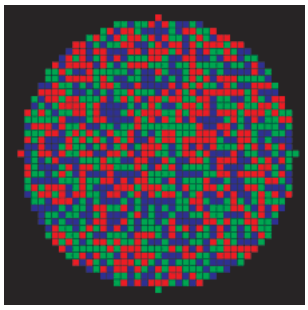
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5.1 Example 1: A simple 3-language society

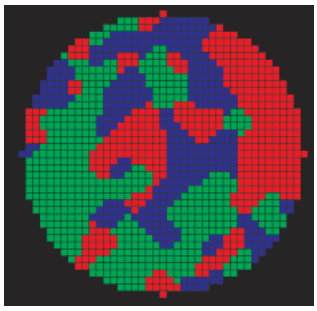
Now, I present a simple society: an island is inhabited by ordinary people (influence only on / from neighbors) that speak 3 different languages (red, green, blue), without any particular previous preference (no attractiveness to a particular language).

As we can see in following pictures, after short period, a stable configuration is obtained: every person decide which language has to use with every his neighbors.

Fig. 1



Initial state:
3 languages known and spoken Red, Green and Blue



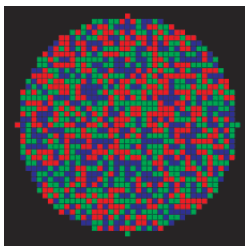
Final state:
A stable configuration with all 3 languages spoken

The global result is that all three languages will survive in specified context.

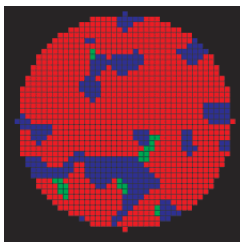
Now, we introduce a «bias», i.e. an random preference of a language in respect of the other two, that preference changes over time. This phenomenon (can) means a temporary attractiveness of one language with respect to the others: «What happen if a language is preferred to another for accidental reasons?»

The scenario dramatically changes:

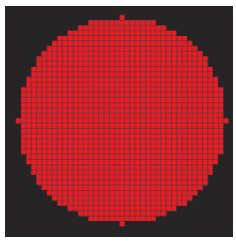
Fig. 2



Initial state:
3 languages known and spoken Red, Green and Blue



Intermediate state:
Languages Blue and Green are spoken only in little enclaves



Final state:
Only Red language is spoken worldwide

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In a very short period, only one language will prevail: other languages continue to be known (they remain in agents repertoires), but aren't spoken.

If we adopt «speaker mass» as a criterion for ethnolinguistic vitality, two languages die.

Instead, if the criterion is «domains in which the language is used», we have a (little) better situation: two languages have not died, but are dying because they are not used anywhere and probably are not taught to next generation.[27]

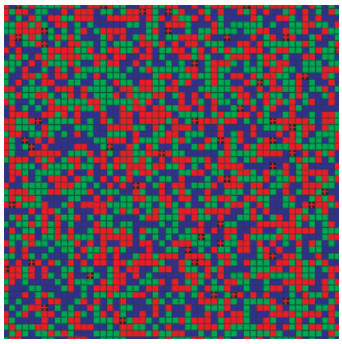
Support actions are necessary to prevent language death!

5.2 Example 2: A support by mass-media

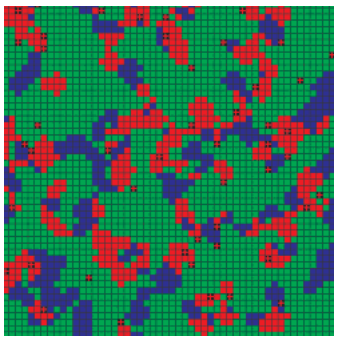
Now we introduce a simple power structure, based on «mass-media» modeled as:

- immutable agents (their language spoken can't be changed, like a governmental radio that doesn't follow listeners' wishes...);
- high influence level (high impact on its neighbours);
- high radius of influence, not only on their 8 neighborhood as in previous model;
- random distribution over the arena.[28]

FIG. 3



Initial state:
Red crosses are mass media supports
for Red language



Final state

[27] In general, it's possible to simulate birth and death of agents with peculiar identity derived from their parent's ones; our simulations are made with «immortal» agents; changing agent complexion of agents over time is equivalent to the change profile of a population over time to genotypic inheritance or phenotypic interaction.

[28] Other criteria:

- density of mass media 2%;
- density of multilingual (agents who know 2 or 3 languages) 70%;
- density of monolingual (knowledge of one, and only one language) 28%.

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The results of this simulation are very impressive:

- though mass media only support Red language, the green language prevails;
- red language support prevents either Red or Blue language death.

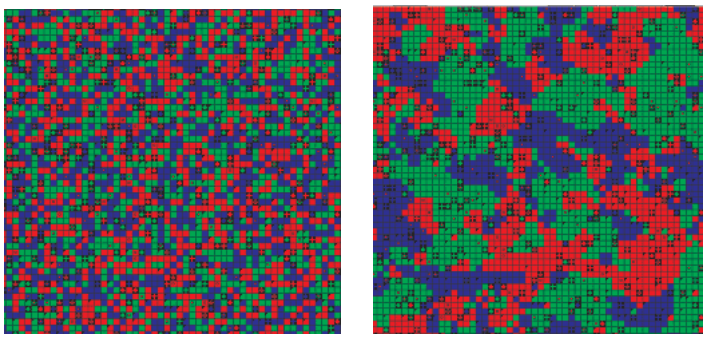
None of these results could be foreseen in advance, from agents characters or from interaction rules! This is a «demonstration» of results emerging from bottom interactions.

5.3 Example 3: A complex arena

In the real world, agents are of many kinds, like those introduced in the last example:

- agents like ordinary people (1 or 2 languages known - Pico della Mirandola's language knowledge is not modeled!);
- «anti testimonial» agents: thought they are able to speak all languages, they cannnot influence anyone... (like Mussorgsky's Simpleton, who in Boris Godunov tells the Truth but nobody follows him...);
- «rural» intellectuals,[29] modeled as ordinary agents who act first (first to decide what language is to be used);
- «urban» intellectuals: agents with high influence: the higher the influence, the greater their capability to get people to use their preferred language;
- «fanatic» agents: they know and use only one language: their own;
- «private» mass media: medium influence, high range, but their language can vary, according to people's listening preference;
- «nationalistic» mass media, same range and less influence than «private» ones, but immutable in language spoken (it's the Party Line...).

FIG. 4



Initial state Final state

[29] «urban» and «rural» intellectuals are terms used by Gramsci (see above, note 24).

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What do those complex results mean?

6 From a «videogame» toward a decision support system

The previous figures are somewhat toy-like...

To make credible all those simulation, we have to increase the links between the simulated word and the real one (where people spend their life, and sometimes put out the lives of their antagonists..., where linguistic and sociolinguistics live studying what is blood and flesh for others ...).

We have to increase the similarity of our models.

In mathematical terms, we have to «normalize» simulations parameters, adopting ones coming from specific, sociologic studies.

Just as a suggestion, I propose two ideas:

- when there are many different languages from one root (local variants), language choice can depend on «phonologic distance»[30] from two vernacular variants; it should probably be possible to simulate the birth of a new language or also of a «pidgin»,[31] when inter-comprehension isn't possible;
- *bias* (i.e. attractiveness of one language with respect to the others —see example 1) can be obtained from «internal intention to use a language», which arises from very complex in-field surveys.[32]

In short, there is a lot of work still to do!

[30] R. Bolognesi and Wilbert Heeringa (Rijksuniversiteit Groningen) studied phonologic distance in 54 local variants of Sardinian [SRD]. Distance is measured by Levenshtein as the that measures alterations necessary to go from one variant to another (private communication); see also R. Bolognesi & W. Heeringa, *Sardegna fra tante lingue. Il contatto linguistico in Sardegna dal medioevo a oggi,* Cagliari, Condaghes, 2005.

[31] An Agent-based simulation of emergence of a vocabulary is: M. Yeo Huimin, K. Lam Kar Yan & Wong Xiu Ming, *The Emergence of Vocabulary: The Birth of Buay Tahan.* USC3001 Complexity (4th April 2003) [`http://staff.science.nus.edu.sg/~parwani/project1/vocab.doc`].

[32] I tried to study the «intention to use Sardinian [SRD]» in high school students, adopting methodologies arising from marketing studies. See Piero A. Bianco, «Esperienze di indagine sui Clienti,» *Qualità* (March 2002).

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