SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

# Methodological novelties applied to the anthropology of food: agent-based models and social networks analysis

## Novedades metodológicas aplicadas a la antropología alimentaria: modelos basados en agentes y redes sociales

*Diego Díaz Córdova*[1]

[1]*Ph D. in Anthropological Sciences. Researcher. Instituto de SaludColectiva, Universidad Nacional de Lanús, Argentina.*

**ABSTRACT** The aim of this article is to introduce two methodological strategies that have not often been utilized in the anthropology of food: agent-based models and social networks analysis. In order to illustrate these methods in action, two cases based in materials typical of the anthropology of food are presented. For the first strategy, fieldwork carried out in Quebrada de Humahuaca (province of Jujuy, Argentina) regarding meal recall was used, and for the second, elements of the concept of "domestic consumption strategies" applied by Aguirre were employed. The underlying idea is that, given that eating is recognized as a "total social fact" and, therefore, as a complex phenomenon, the methodological approach must also be characterized by complexity. The greater the number of methods utilized (with the appropriate rigor), the better able we will be to understand the dynamics of feeding in the social environment.
**KEY WORDS** Anthropology; Feeding; Computer Simulation; Nonlinear Dynamics.

**RESUMEN** En este artículo presentamos dos modalidades metodológicas que aún no han sido muy utilizadas en la antropología alimentaria. Por un lado, nos referimos al análisis de redes sociales y, por otro, a los modelos basados en agentes. Para ilustrar los métodos, tomaremos dos casos de materiales clásicos de la antropología alimentaria. Para el primero usaremos los platos de comida de un relevamiento hecho en la Quebrada de Humahuaca (provincia de Jujuy, Argentina) y, para el segundo, utilizaremos algunos elementos del concepto aplicado por Aguirre de "estrategias domésticas de consumo". La idea subyacente es que, dado que la alimentación se reconoce como un "hecho social total" y, por lo tanto, como un fenómeno complejo, el abordaje metodológico debe seguir necesariamente esa misma característica. Mientras más métodos utilicemos (con el grado de rigor adecuado) mejor estaremos preparados para comprender la dinámica alimentaria en el medio social.
**PALABRAS CLAVES** Antropología; Alimentación; Simulación por Computadora; Dinámicas no Lineales.

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

## INTRODUCTION

According to Marcel Mauss,[1] what later became a theoretical axiom, feeding is a "complex social fact." This does not only imply that feeding involves every social aspect (economic, religious, legal, political, among others), but also comprises core aspects, that is to say, physiological and psychological, involving all aspects simultaneously. Feeding is, for human beings, an issue that covers from the molecule to the symbol. But on a daily basis, feeding is a phenomenon that takes place more than once per day, and it is perceived as something complete and total, even blurring its origins and causes. Thus, the division set forth in this work is merely analytical.

If feeding is understood as a complex phenomenon, the methodological tools with which it is attempted to be described (or explained, no intention of triggering an epistemological debate) should also be complex. In this sense, we have always claimed that in the anthropology of food it is necessary to use both quantitative and qualitative methods, as each of them covers different aspects of the problem, and if adequately combined, a more complete comprehension of the phenomenon is accomplished.

In this article we pretend to introduce two methodological tools that help provide meaningful contributions to the anthropological study of feeding. On the one hand, we refer to the analysis of social networks, which is a relational methodology, different from classical analyses that are attributive, in which the units of analysis are defined and features of them are mentioned.[2] This methodology is based on the connection among nodes, thus the approach is completely different. On the other hand, we refer to agent-based models, which are computer simulation models[3] that enable a deeper knowledge of the topic being studied and to try out different scenarios applying the *caeteris paribus* clause (a novelty in Social Sciences at least outside the range of the classical quantitative methodologies).

Due to the fact that methodological tools depend directly on the theoretical framework, we will have to consider different points of view regarding the usage of the analysis of social networks or agent-based models. In other words, all of the methodologies chosen require a particular perspective, a way of understanding the world, which makes sense of it. Regarding the theory, the key is the proper identification of its levels: there will be a hypothesis in a general level, and another having a mid-range.[4] Methodology tends to connect mid-range theories with empirics, given the fact that the general theory is responsible for providing the main grounds, and it is the one that states the assumptions. In the analysis of social networks, it is important to identify the relationships that govern the players.[2] In the case of agent-based models, what is relevant is the identification of the rules used by social players in their actions.[3] In the first case, the emphasis is placed on relational character (the social relationships chosen); in the second case, the stress is placed on the normative aspect (from the player's point of view).

In this article, we will introduce two cases that aim at demonstrating the advantages and disadvantages of using this type of methodology. Regarding the technical proficiency necessary to be able to use them, what really matters is not the technological knowledge, but the way of thinking and approaching the scientific problems. We might say that technological knowledge is, in a way, spurious; what is truly hard is to change the way of thinking and understanding that the stress is placed on the relationships, in the case of social network analysis,[2] and on the abstraction of the rules of conduct, in the case of agent-based models.[5] Therefore, the objective is purely didactic, with the purpose of tempting the curious researcher to taste these new methodologies and to learn about them, in order to, in case of rejecting them, do it based on clear grounds and not on preconceptions or trend effects.

Finally, we would like to mention that these methodologies are framed within what is known as complexity theory and chaos theory. These theories, which are the

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

updating of the classical systemic theories, constitute what is known as "algorithms of the complexity,"[6] that is to say, they are algorithmic expressions of complex or chaotic phenomena. The networks, with their "little world" behavior or their "networks free of levels" setting, make it possible to appreciate (in their wider sense) a complete range of phenomena that was formerly suspected but not formalized. Agent-based models enable us to observe how the emerging behaviors are generated, that is to say, features that cannot be inferred from their initial conditions and that are highly sensitive as they respond to all the actors, relationships and contexts involved. These theories and their corresponding methodologies are not specific, in the sense that they enable us to address different types of problems, regardless of their semantics. Consequently, they are classified within the theoretical concepts of middle range. In other words, they require, in order to be correctly understood, a set of hypotheses that provide them with specificity. In this case, they depend on the general concepts of an anthropology of food. This topic will be further discussed in the corresponding sections of each of the methodologies introduced.

The empirical data included in this article was taken from my PhD thesis[8] and is based on the fieldwork carried out between 2005 and 2010 in Quebrada de Humahuaca, a region located in the province of Jujuy in the Northeast of Argentina. This area is characterized for being located amid the Oriental and Occidental ranges of the Andes Mountains. The direction of the Quebrada is South-North, rising towards the northern region until it meets what it is known as Altiplano(highlands) or Puna. Human settlement in this area dates back to more than 10,000 years ago, and agriculture was introduced 4,000 years ago.[10]

## ANALYSIS OF SOCIAL NETWORKS

Before starting with the example of social networks, we consider it necessary to establish some relevant distinctions. The concept of networks is widely spread, especially regarding the use of web platforms called social networks. The methodology introduced in this article is slightly connected to *Facebook, Twitter,* or *LinkedIn,* although these websites can be used as a subject matter. We prefer to define these platforms as *cyber networks*.

In general, there are three usages identified for the concept of network. First, network is used in the metaphorical sense. In scientific bibliography, the term network is often used to refer to a more or less cohesive group, generally of people, that share certain connections among them.[11] This usage does not go deeper into the formal aspects of the network, but strictly in the metaphorical aspects: a network is adopted, but no research is made on it. Second, the pure meaning of the term *networking* is a concept in itself. In this case, it refers to the possibility of acting in a network (also not clearly defined, without specifying its components). This is what people working in public relations or marketing usually do – they deal with networks intuitively, taking advantage of the situation. Third, there is the formal concept, which is the one being introduced here, that considers the components and the features of the reticular phenomenon.[2] What really matters here is the structure of the network and the measures that can be applied to it. Here, it is not important to know (from a theoretical point of view) if the network is composed of people, institutions, goods or any other thing; what it is truly important is to define the nodes and ties correctly.

The origin of social network analysis, in reference to the last definition, dates back to the 18$^{th}$ century, when mathematician Leonard Euler set the basis for the Graphs Theory, starting from a classical game of his time that consisted of crossing the Seven Bridges of Königsberg, without repeating any of them and returning to the starting point. Euler found the answer, or we might say, the "no-answer," given that it is impossible to cross all bridges without repeating some of them. From this, he developed the Graphs Theory. His abstract answer implied a change

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

in the way of coping with problems that later resulted in the nomenclature based on points or nodes and edges or ties.

The social network analysis, in connection to social sciences, dates back to the 1950s, when anthropologist John Barnes coined the term "social network" in order to study African societies and their relationship during the decolonization period.[12] Although the concept and the related methodology were not quite taken into account by the discipline in its mainstream form, as from the 1990s, partly as consequence of being able to use personal computers (and, therefore an enormous computing power), and the social outbreak of the *world wide web*, this way of approaching the studies started to be increasingly popular (although it is important to clarify that it does not make part of the main methodological background of social sciences yet).

In strictly descriptive terms, a social network may be described as an entity containing *nodes* and *ties*. A node is simply a unit that represents the object of the connection. A tie is merely a connection between at least two nodes. What is considered to be a node or a tie depends only on the researcher's imagination.[2] In general, units of analysis tend to be used as nodes (whether people or group-institutions), and the binding features as ties (flows of goods, services, or any other entity, among those nodes). From this simple definition, it is possible to obtain centrality measurements and other types of measurements that enable us to distinguish the underlying structure of the phenomenon and observe, for instance, who is placed in the central position (who has more ties), who connects network areas (who acts as a bridge between two areas of the reticular network), or what level of cohesion has the network as a whole (how connected it is). Each node may have attributes, that is, features that define it beyond its reticular value. At the same time, each tie may have different origins: its presence/absence may be mentioned, it may be routed, and it may be weighted (that is, each tie may have a greater or lesser flow measured in some kind of units).

## The social network analysis applied to a network of foods consumed in Quebrada de Humahuaca

For this PhD thesis,[8] we decided to use the social network analysis and to process the 24 hours-meal recalls, developed in the fieldwork carried out in Quebrada de Humahuaca. The idea was to try to apply this methodology in order to observe if different eating patterns among the household units studied could be found. Generally, meal recalls are quantitatively processed (for instance, observing frequencies), and even though in the thesis we applied that traditional methodology, we also intended to study their structure from the social network analysis point of view.

The starting point was a two-mode network, that is a network in which the entities are of two types; for instance in our case, families and food. We originally had data of each household unit and the food they consumed in the last 24 hours. Therefore, we did not have a square matrix, but a rectangular one (there is no similarity between the number of columns and the number of rows). In general, for the analysis of social networks, it is recommended to use square matrices in which not only the number of columns and rows matches in their cardinal sense, but also in their semantic nature. That is, the labels of the columns and the rows must be the same. We used the classical procedure[13]: we extracted two one-mode networks from a two-mode network. This means that in our example, two families were connected if both had consumed the same type of food and, on the contrary, two foods were connected in case one family had consumed both (Figure 1).

We built the network we worked with (in this work represented as a graph) from this matrix. From the two networks taken, we only worked with the one containing the food (Figure 2).

The graph is displayed in such a way that foods having the greater number of ties are placed in the middle, and those having less ties are located in the peripheral area. One of the keys for understanding these type of networks is that they do not consider, at least in

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

our case, the quantitative frequencies of consumption, they only focus on the presence or absence of the tie. That is to say, the amount consumed of that food is not relevant, what matters is whether they have consumed it. If we examine the reticular data, it can be observed that industrial food takes the central place, but homemade baked food is placed extremely close to them. This shows what can also be seen in our fieldwork and that, in a way, rejected one of our original governing hypotheses: foods in Quebrada de Humahuaca are not divided into two types as we have assumed – one industrial and the other local. On the contrary, household units use both according to the possibilities and the particular suitability.

That is to say, in this case, social network analysis was used as an extra test of what we have observed in the fieldwork. Both eating

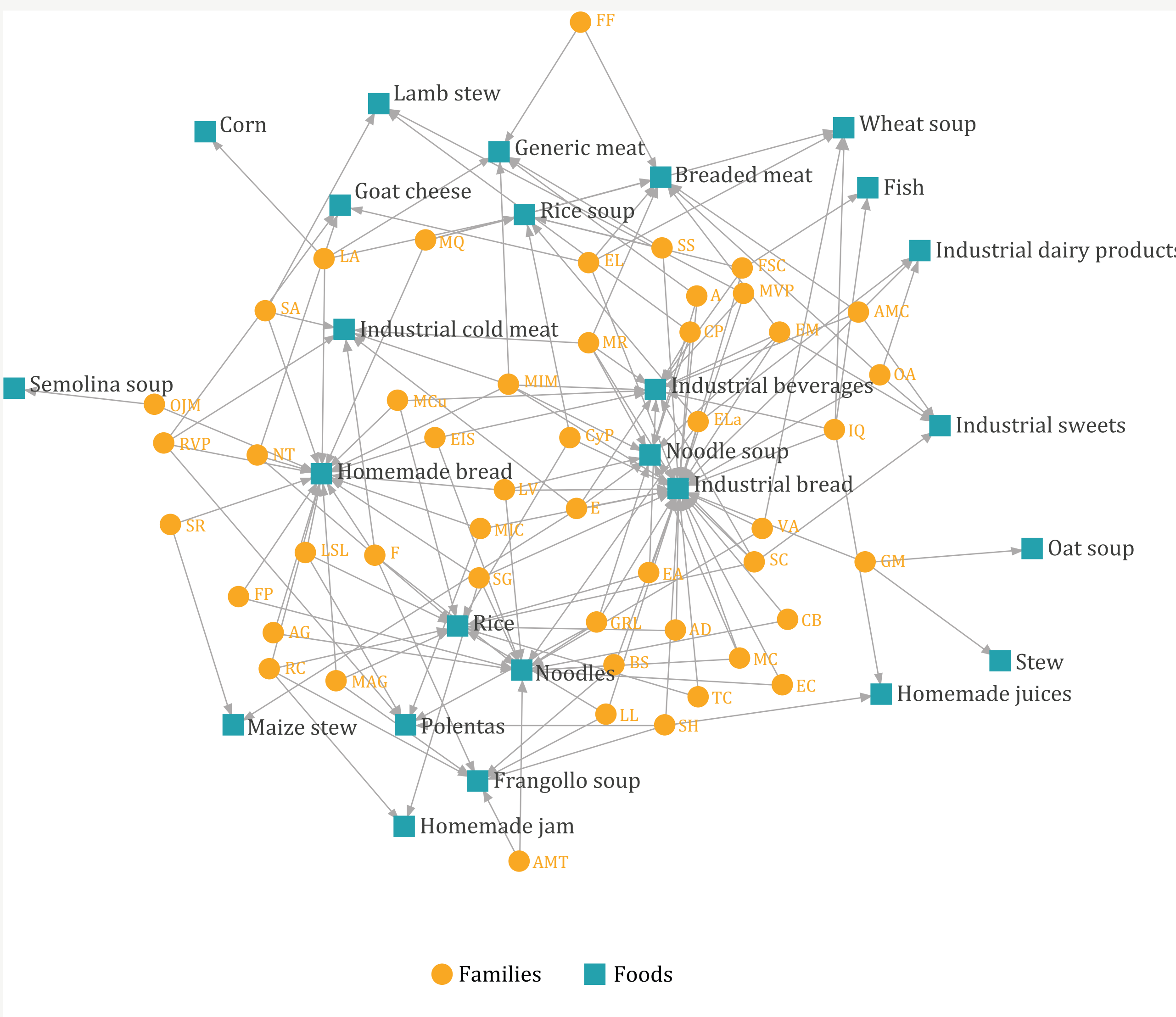



Figure 1. Two-mode network made on the basis of 24 hours recalls. Quebrada de Humahuaca, Jujuy, Argentina, 2008.

Source: Díaz Córdova.[8]

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

patterns (industrial and local) cannot be noticed in classical statistical analyses, mainly, because foods produced in the local sphere are not found in the formal markets. The only way of observing that situation is by carrying out the classical anthropologic fieldwork, from which a new type of information arises, connected to the practices and representations of actors and the meaning people give to their eating acts. Although this was observed and registered time after time, as it directly affected one of our main hypotheses, we decided to test it in a different way. That is how we used the social network analysis as a way of observing the phenomenon from an independent perspective.

Due to its extension, we will not be able to present all the measurement alternatives that the social network analysis offers. In addition to the level (amount of ties), which

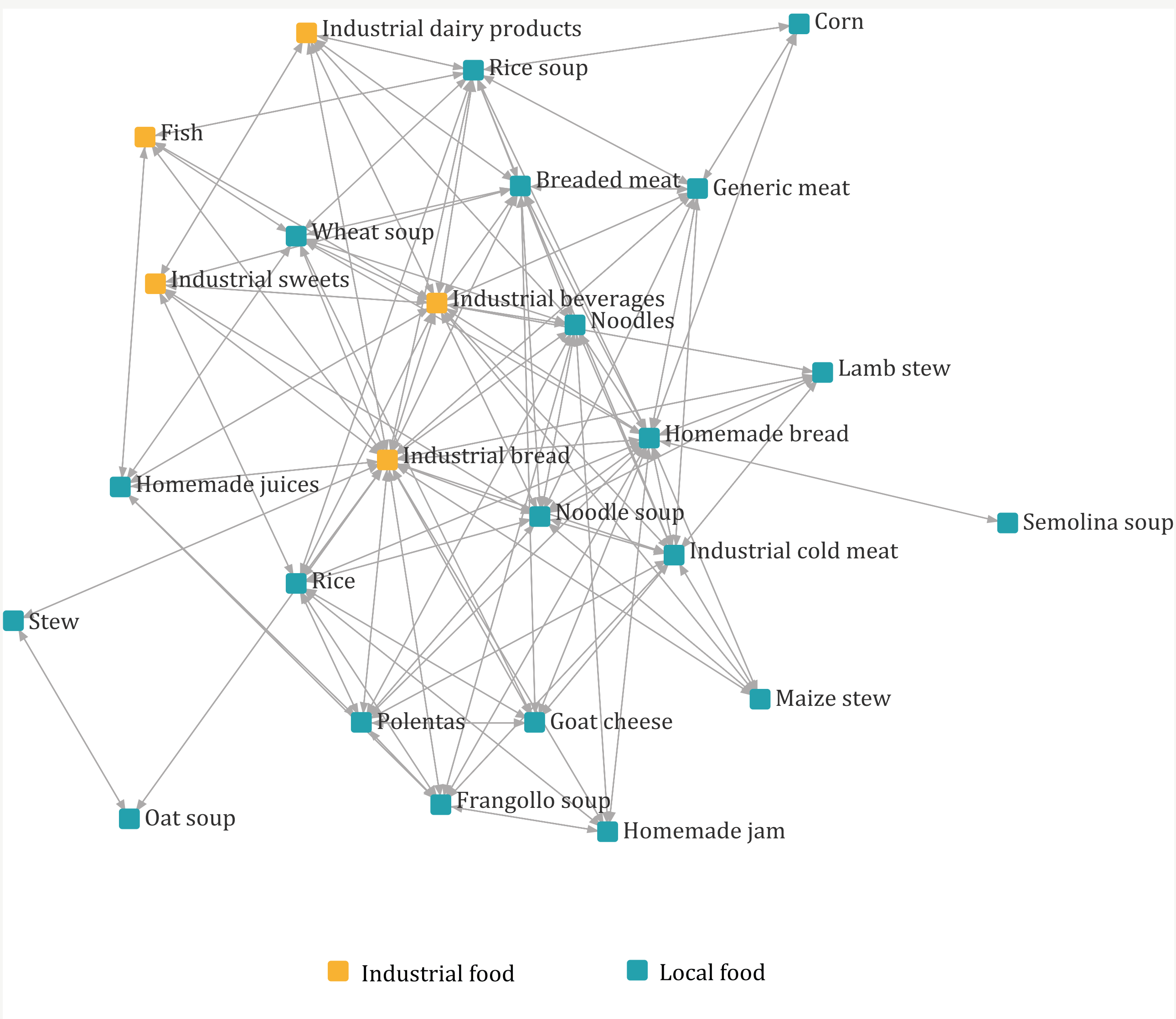



Figure 2. One-mode network displaying the food consumed by the different families. Quebrada de Humahuaca, Jujuy, Argentina, 2008.

Source: Díaz Córdova.[8]

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

is displayed in this work, there are other measures that may be found in our PHD thesis,[8] particularly from the food anthropology area.

## AGENT-BASED MODELS

Agent-based models are a formalism whose origin dates back to the cellular automata; therefore, in order to understand the former ones, we need to know, at least, what the latter are.

A cellular automata is a mathematic model of a dynamic system.[14] It can be defined as a collection of discrete and deterministic cells in a row, in a grid, in x dimensions, in which the value given to each cell is a binary feature (presence or absence, on or off, alive or dead, true or false, and so on), and whose state is updated throughout an also discrete period of time, according to the state of the neighboring cells.[6] When we refer to a discrete period of time, we mean that it is not a permanent extension of time for this type of model; that is, as in turn-based games, where each player has a period of time on his own (as in chess). The collection, whether in a row, in a grid, or in more dimensions, might have a well-defined edge or connect the ends among them. This second option is the most chosen one, and it can be distinguished if we think of a *Pac-Man* board (where the little ghosts and the *Pac-Man* itself went out by one of the sides and came back in by the other side). The update is performed in a discrete and synchronous way; the neighborhood tends to be orthogonal, or it may also include diagonals (in the case of a grid, two dimension); the neighboring radio is defined in advance and can be of 1 (the neighboring cells) or x, depending on the researcher's intentions.

In social sciences, these type of models are often called "board" models. There are some famous ones, like the one developed by Thomas Schelling in 1969,[6,15] which contributed to model racial segregation problems, in which it is shown that it is not necessary to be an active racist in order to attain well-differentiated geographical areas according to ethnic groups (*ghettos*). A similar model, but developed in an independent way, was Sakoda's model, in which it was attempted to observe the behavior of Japanese people in relocation fields in the US during the Second World War.[6,16,17]

Agent-based models are extensions of cellular automata. First, *agents* that are placed on the *board* appear. These agents may have different features, and their values are not restricted to binary values: they might be of any type that the researcher considers to be convenient. In some kind of virtual sense, therefore, agents *live* in the board. Second, each cell of the board is not restricted to only two binary values, it might also be enunciated the amount of variables considered to be convenient for each cell and assign them a desired quality (that is, variables may contain any type of information); this makes the board computationally active and makes it possible to simulate almost everything on it.

An example can illustrate in a better way the power of agent-based models. Probably, the most famous implementation should be "Sugarscape," a model developed by Joshua Epstein and Robert Axtell.[18] This model consists of a board in which a resource called "sugar" is distributed non-randomly. The distribution follows a pattern of circles, where the most orange area matches to the bigger concentration of the resource, as displayed in Figure 3.

In figure 3, the dark orange area indicates that the cells of that region have more units of "sugar" than the areas having a lighter orange color. Once the resource is consumed, depending on the user's interest, it may grow again immediately, gradually, or not grow at all.

Agents who "live" on this board have a set of features: vision ability (measured according to the number of cells that they can see), metabolism (which indicates the amount of "sugar" needed by each agent in order not to die due to starvation), and age (updated in each "turn" of the system and which, once it reaches a limit raffled randomly among the

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

agents, determines its death). In accordance with the features of the board or world and that of the agents, a set of rules are set up in order to indicate both the conduct of the agents and the conduct of the world. These rules state, for instance, how much the sugar should grow, once consumed, and they also indicate the way in which agents should distinguish, regarding their visual capacity, which cell contains the biggest concentration of sugar, go towards there, and then consume all the resources found. What is not consumed by the metabolism will be stored. Figure 4 displays an example of a board with the agents.

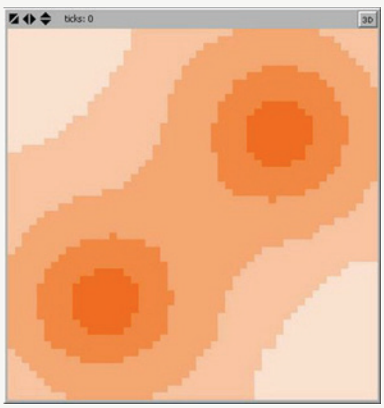



Figure 3. Visualization of the distribution of the resource (sugar) on the board of the Sugarscape model - in accordance with setting shaped by Netlogo.

Source: Centre of Interdisciplinary Science.[19]

This model, with its evident simplicity, makes it possible to simulate complex phenomena. For example, the authors show how an uneven distribution of wealth occurs, or how social Darwinism can be rejected by means of a model, or how a disease can spread or a cultural identity can be developed.[18] One of the keys of these types of models is that they enable play with the heterogeneity of the agents and their environment. In contrast to statistical models that require certain homogeneity so that the measures have meaning, or qualitative models that emphasize diversity, agent-based models enable the exploitation of the best of both worlds, defining themselves as an excellent area to test qualitative hypotheses and observe how, from the local interactions, large statistical summaries are produced. In conclusion, these types of models are not quantitative nor qualitative, they are placed in a phase transition, in an intermediate methodological gap. As Reynoso states:

> The ABM (agent-based models), with their little ants and their sugar prizes, undoubtedly have a touch of stupidity, as if the real life were too large for them; but, in the process of their treatment, one forces oneself to reflect on the overflowing implications of any statement on a cultural world ruled by nonlinear principles.[6]

## An agent-based model about food exchange in Quebrada de Huamahuaca

The model developed and presented in this work is the result of the fieldwork carried out in Quebrada de Humahuaca,[8] which served

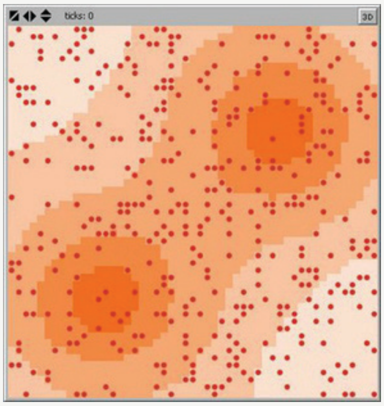



Figure 4. Visualization of the distribution of the agents and the resource (sugar) on the board of the Sugarscape model, in accordance with setting shaped by Netlogo.

Source: Centre of Interdisciplinary Science.[19]

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

as a resource in order to abstract certain rules regarding eating behaviors, specifically connected to the food reciprocity and exchange, and apply them in the agent-based model.

When working with an artificial society, it is a priority to bear in mind the slice of reality selected. The holistic fiction of ethnographic writing shatters when facing the restrictions imposed by computers. The design of a model of this type demands some methodological decisions to be made, given that not everything can or must be simulated, but a selection criteria that fits the set of hypotheses chosen must be implemented.

The great advantage presented by *Artificial Societies* – one of the names of the agent-based models used when working with social data – is that they enable each unit selected as the focus of the simulation–in our case, household units–to be different among them. The variability of each agent is one of the keys of the potentiality and that is what moves this methodology away from the assumptions that govern statistical models,[8] where it is necessary to reduce the diversity of subjects for the benefit of the measurements that summarize all the data, such as the average or the standard deviation. This diversity feature is, at the same time, what places these models closer to the ethnographic perspective. The advantage that artificial societies have over ethnography is the possibility of observing in real time (in computing terms) the dynamics of the phenomenon that is under analysis, as well as *reproducing* it, verifying the observations made in the real world or suggesting new ties and connections.

From our perspective, artificial societies are a complement to the anthropologist's methodological baggage, which adds dynamism and synthesis to ethnographical variability (used as supply) and, at the same time, they have the ability to express and describe the results obtained in statistical terms, if it were necessary.

It should be mentioned that artificial societies are able to play the role of the operative and methodological complement of theoretical concepts connected to *habitus*[20] or with the agency,[21] making it possible to observe (within a controlled environment) how they develop and which is the scope that the subjects' actions have (whether they are people, household units, or any other relevant concept).

We try to observe the consumption dynamics of two types of foods (industrial and local) in connection with two aspects: 1) food supply through purchase or production, and 2) food supply through reciprocity and exchange with neighbors and relatives.

If we consider the concept of "domestic strategies of consumption,"[22] it can be noted that the "diversification of the supply sources" is within its dimensions. This means that the sources from which the household units stock up on food are diverse and are not located in only one place. In this sense, one of the sources to be taken into account is the exchange of food within the extended family inner circle (within which close friends are included). In other words, food supply is not only connected to the different types of stores where goods can be purchased, for the contributions made by the State as well as by some other non-governmental organizations and food exchanges outside the formal system are also included.

In these informal dealings among relatives, food coming from rural production of the Quebrada is traded, and that is what we pretended to represent in this agent-based model.

But the origin of food, their belonging to industry or local production, became evident only when we analyzed the data gathered during the fieldwork, as this information cannot be found in or inferred from official statistics. It can be observed, in the social networks registered in the urban areas that were previously displayed, that there is an important, although not absolute, presence of industrial food. There are also, in an outstanding position, some foods considered to be local, such as homemade bread or goat cheese. The urban area did not have a 100% matching with industrial food consumption, as there were also local food productions. During the interviews held, the complexity of the eating system was made clear. As from

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

these interviews it was revealed, to all its extent the influence of local production and the alternative circuit of the capitalist market, which are part of the consumption strategies of the household units.

We tried to replicate this dynamic in our artificial society: industrial and local food consumption heterogeneously distributed within a spatial location, where industrial food is observed in the rural area and local productions are spotted in the urban area.

For its *in silico* (simulated) replication, we work based on the eating behavior rules registered during the daily interaction with people in the fieldwork.

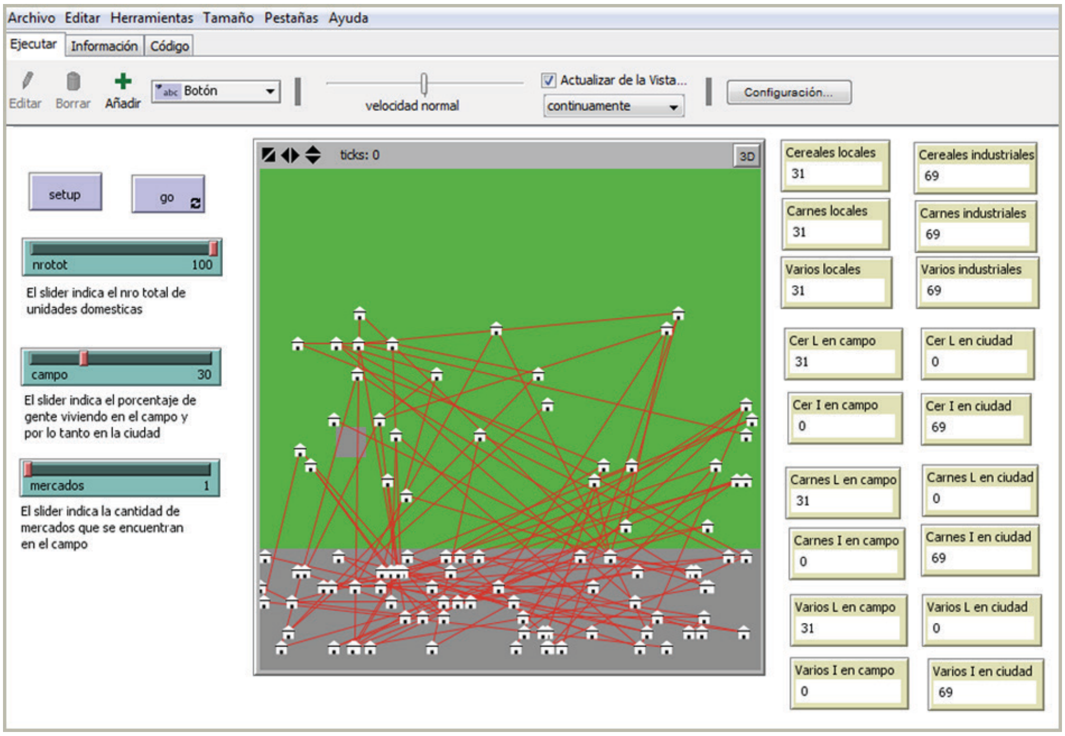
We assumed, for our agent-based model, that the household units were not differentiated for their income, but for their possibilities of: consuming industrial food or local production food. In this artificial society, we removed all household units which had high income and that, therefore, could satisfy their eating needs more easily. Having a higher income enables, although food demand is always inelastic (tends to have a limit),[22] the possibilities of election (and prevision) to multiply in accordance with that same income. In the world we have created, inequality was not based on the income or the property owned by people, but on their geographical location. We are aware that we have created a fiction, but in any case, one interested in and consistent with the objectives of one of the aspects of the research. The flexibility of the artificial societies is one of their most valuable contributions.

Let us now describe our system. In Figure 5, a screen in which a board divided into two areas, one green and the other one grey, is displayed. Within the green area, there are gray squares distributed on the lower section of this area. There are little houses that represent our household units, randomly distributed all over the board. The green area represents the rural area, whereas the gray one constitutes the urban area or, in other words, the place where it is possible to get industrial food. Each little house represents a household unit that has edges coming out of each of them and that connect them with other little houses distributed on the board. These bonds represent the social ties of the household units, which, in some cases, have one bond; in other cases, two bonds; they might occasionally have three bonds; and there might be a reduced number of cases having more than three bonds. The rule that assigns those bonds is the random rule. All household units are visited, and a bond with another household unit is randomly assigned to each of them. The restriction is that one household unit cannot have a bond with itself. We should not forget that the *pseudo random* used by the computer tends to have a *gaussiana* distribution. We decided that the best way of establishing bonds was by randomness, due to the fact that we considered that distribution adjusted to what we observed in the field; that is, although in real life people do not bond randomly, there is a background that determines the types of bonds created. The truth is that the final setting (for our objectives) is very similar to the principle of randomness, especially because in this work we take as a bond principle the possibility of exchanging food in a predetermined direction, and that goes from the countryside to the city and not necessarily social relationships as a whole. Certain studies state that, for example, sexual bonds or friendship bonds comply with a power law within a society.[7,12] Throughout our observations, we did not find that people from the urban area send industrial food to their acquaintances in the rural area, but we did observe the opposite: a lot of people having connections in the rural area carry some foods that are always produced locally from there.

The consumption of industrial food in the rural area is due to its proximity to the urban area (the gray zone in our model) and to the stores distributed within the rural area (gray squares) (see Figure 5). As from this concept, we measured the distance to those places, and in accordance with those measurements, we implemented a random criteria again: as a household unit approaches to one of the gray areas, the probability of obtaining industrial food increases.

Among the commands identified in the interface (Figure 5), there is a Setup key,

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008




| Local cereals | Local meat | Other local food | Local cereals in the countryside | Industrial cereals in the countryside | Local meat in the countryside | Industrial meat in the countryside | Other local food in the countryside | Other industrial food in the countryside |
|---|---|---|---|---|---|---|---|---|
| 31 | 31 | 31 | 31 | 0 | 31 | 0 | 31 | 0 |
| Industrial cereals | Industrial meat | Other industrial food | Local cereals in the city | Industrial cereals in the city | Local meat in the city | Industrial meat in the city | Other local food in the city | Other industrial food in the city |
| 69 | 69 | 69 | 0 | 69 | 0 | 69 | 0 | 69 |

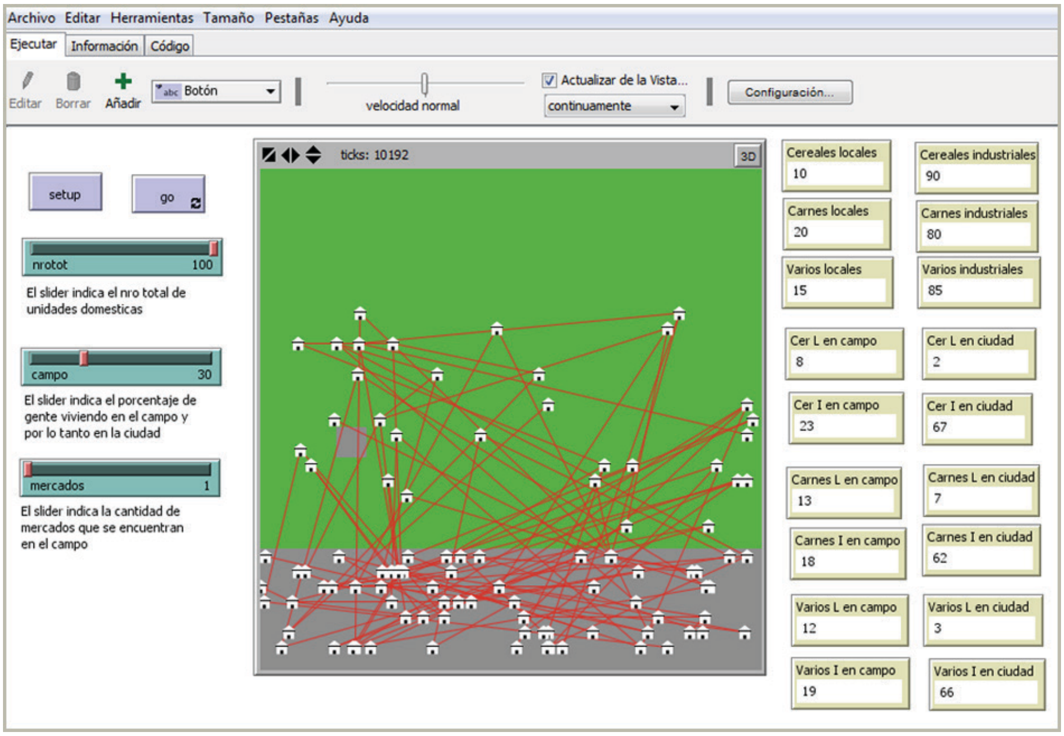
Figure 5. Visualization of the distribution of household units within the rural and urban areas, in the NetLogo interface. Quebrada de Humahuaca, Jujuy, Argentina.

Source: Díaz Córdova.[8]

which configures the scenario, executes the routines that create the urban area, the rural area and the stores, and it also creates and distributes the household units and their bonds.

Furthermore, through the Setup function, the foods that household units have by default are assigned. The starting point is always a distribution in which the urban household units have purely industrial food, whereas the rural household units have only locally produced food. The Go key sets the system permanently in motion, that is to say, it does not perform one round and stops, but it continues until the user decides to stop the performance. Within the Go routine, household units exchange foods with their bonds in the rural area, and then they supply themselves with food: if the household units are located in the green area, as it was previously stated, the distance to the gray area determines the probability of getting industrial food; if this does not occur, then the household units supply themselves with locally produced food.

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008




| Local cereals | Local meat | Other local food | Local cereals in the countryside | Industrial cereals in the countryside | Local meat in the countryside | Industrial meat in the countryside | Other local food in the countryside | Other industrial food in the countryside |
|---|---|---|---|---|---|---|---|---|
| 10 | 20 | 15 | 8 | 23 | 13 | 18 | 12 | 19 |
| Industrial cereals | Industrial meat | Other industrial food | Local cereals in the city | Industrial cereals in the city | Local meat in the city | Industrial meat in the city | Other local food in the city | Other industrial food in the city |
| 90 | 80 | 85 | 2 | 67 | 7 | 62 | 3 | 66 |

Figure 6. Visualization of the distribution of the household units in the rural area and in the urban area after 10.192 runs (ticks) in the NetLogo interface. Quebrada de Humahuaca, Jujuy, Argentina.

Source: Díaz Córdova.[8]

In this work, foods were classified into three groups for two variations. We divided the food pattern into *cereals* (including all types of vegetables); *meat* (all types of meat), and *others* (including everything else). This classification is, at the same time, divided into local and industrial food. All this simplification regarding real life information is justified in the objective of the model proposed, which is to observe in a dynamic way how these foods distribute accordingly with the supply strategies of the household units: on the one hand, the exchanges, and on the other hand, the self-consumption, and lastly, the possibility of obtaining industrial food in the formal market.

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

The interface has a control called *"nrotot"* that defines the number of household units that are going to be drawn in the world. There is also another control called *"field"* that determines the percentage of people living in the rural and urban areas. As it is shown in Figure 5, that value is 30, which means that 70% of the population live in the urban area, whereas the remaining 30% live in the rural area. Finally, there is a control called *"markets"* which indicates the number of stores that may be found in the rural area. In this version, the possibilities go from 1 to 6.

In Figure 5, to the right of the scenario, it can be seen that the interface has a variety of controls that enable monitoring of what is happening with the food in every round (each tick). The first six controls show the general distribution of foods, divided into local and industrial foods and into food categories. The following twelve controls show those same foods, as they occur regarding the area. In this way, the diverse local and industrial foods are well differentiated, in the countryside and in the city as well.

As it was previously mentioned, we started the runs (that is, the execution of the program) with a distribution that corresponds with the hypothesis we stated at the beginning: everyone living in the urban area consumes industrial foods and everyone living in the rural area consumes local foods. Figure 6 shows what happens after some rounds (ticks), in this case 10.192. The distribution stabilizes, and foods from one and the other category appear in the city and in the countryside as well. Of course, a tendency is always displayed: there are more industrial foods in the city, whereas there are more locally produced foods in the rural area. What does this show? On the one hand, it shows that the eating pattern, just as it happens in real life, differs from one area to the other and is not homogeneous, as it has been assumed in the first place, and on the other hand, that one of the keys is the exchange processes driven by reciprocity, which enables a certain influx of locally produced foods towards the city. The fact should be highlighted that, in our model, the only way to obtain locally produced foods is from the bonds that the household units maintain among them and not by acquiring them in any market from the city, as it is frequently observed that occurs in the Quebrada (a clear difference between the model and reality).

What we intended to test with this model was the possibility of reproducing, with special care, a few eating attitude patterns and behaviors shown by the people from the Quebrada and to reflect on the information provided by the field, but from a perspective that does not admit rhetorical games, but that imposes a specific definition even if it is operative and circumstantial. Models based on players are not a panacea, for they do not substitute other methodologies; they enable us to verify if our hypotheses have any trace of reality or at least of plausibility. They allow us to get to know, from a different point of view, the phenomena being studied. The key, as it has been previously stated, is not in the technical control, but in the epistemological look; in the possibility of materializing that mental model that always occurs, and that because of its inevitable nature, is always present. The best way is to treat models, simply, as a way of thinking.

## CONCLUSIONS

We have tried, so far, to present two methodologies that are not commonly used in the food anthropology field. On the one hand, the social network analysis, and on the other hand, the agent-based models. These two ways of looking at the world are embodied within the theoretical movement of the complexity and the chaos. Due to the signs indicating that the universe and everything involved in it is complex, then what could be better than using tools that, with their limitations, account for that evident complexity? Food anthropology is a fertile field for methodological experimentation; as feeding is a "total social fact"(1) and its own study is naturally multidisciplinary, and the methodological experimentation turns out to

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

be necessary. We cannot decline methods due to assumptions or prejudices; they have to be tested, and their scopes and limitations must be verified. We have to be ready to change our point of view and to adapt it to the methods requirements, without forcing its own architecture. A right balance as defined by Aristotle is one that can only be attained in the praxis.

Social network analysis, from our experience, has the advantage of clarifying certain underlying structures, whose existence is suspected or not. It enables, on the one hand, to verify or refute the hypotheses, but on the other hand, it is also a discovery tool. In our case, from the fieldwork, it began to be evident that food patterns (industrial and local) were not separated in the urban area, at least not in the way we have suspected at the beginning. Consequently, we decided to apply the social network analysis to the data already collected, which is also interesting, due to the fact that it can be used similarly with the data that was not conceived in terms of networks and with the data deliberately collected. Therefore, we transformed the 24 hour-meal recalls into reticular data, prone to being analyzed using the classical tools of the social network analysis, in order to understand which food had more connections, at what distance was each food from the others, what degree of cohesion the net had as a whole, and so on.

One of the most evident disadvantages that social network analysis has is that the analyses are synchronic, that is, they take a picture from a specific moment in time. Although many theoretical movements such as structuralism or functionalism use a synchronous approach, it does not avoid the fact that their possibilities are, in a way, limited by that feature. In the case of social network analysis, there is a methodological possibility of observing the trajectory of a network for a period of time although, it must be said, it has certain algorithmic difficulty. In any case, this limitation shows which is the methodology scope, preventing theoretical confusions in this regard.[11]

Regarding agent-based models, we believe that the main advantage is how problems are approached, which is one of the requirements of these types of methodologies. The main issue here is to choose which players (or agents) will be relevant and which characteristics they will have. The same applies to the scenario created, as well as for the relationships among players and between players and environments. In our case, we were interested in simulating the reciprocal connections related to food, within the Quebrada context, where the market and the local production coexist. That is to say, we were interested in applying by means of a computer one of the practices that constitute the "domestic strategies of consumption"[22]; in this case, the diversification of the supply sources in their particular aspect of reciprocal exchange of food. We intended to reproduce that exchange dynamic, exactly as it has been observed in the fieldwork: that synthesis of what we observed, participated in, and recorded what actors say and do, as well as what they say that they do. It was clearly evident that the reciprocal pattern cohabitates within the market and that the local food has certain resilience power.

Models based on actors help to understand the dynamics of what is happening in the social environment under study. One of their virtues is that they make it possible to play with different features and diverse settings; they are tools that enable us to know the ethnographic area from a different perspective, in which the control is clearly exercised by the one in charge of creating the model (social actors and researchers). Accordingly, there are already authors referring to a "participant simulation,"[23] quite similar to participant observation, but applied to the agent-based models.[11]

The big disadvantage of these types of models are that they require certain algorithmic expertise. To a certain extent, knowing the possibilities of the programming language in which the model will be developed enables us to take a better look at the possibilities offered. Another risk that may be detected is the "fallacy of reality," which consists of trying to simulate everything that occurs in the field, creating such a complex

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

model that it may attempt against the advantage of simplicity. In order to be able to use models based on players correctly, the key lays upon choosing and isolating those elements from reality that for some reason are considered to be relevant, either because players make reference to it or because the researcher's theoretical framework has so indicated.

## REFERENCES

1. Mauss M. Ensayo sobre el don: Forma y función del intercambio en las sociedades arcaicas. Buenos Aires: Katz Editores; 2009.

2. Hanneman R, Riddle M. Introduction to social networks methods [Internet]. Riverside: University of California; 2005 [cited 10 Jul 2016]. Available from: http://tinyurl.com/ju54p9b.

3. Wilensky U, Rand B. An introduction to agent-based modeling: modeling natural, social, and engineered complex systems with NetLogo. Cambridge: MIT Press; 2015.

4. Merton R. Teoría y estructuras sociales. México: Fondo de Cultura Económica; 1980.

5. Agar M. Agents in living color: Toward emic agent-based models. Journal of Artificial Societies and Social Simulation [Internet]. 2005;8(1) [citado 10 jul 2016]. Disponible en: http://tinyurl.com/hjm5rwd.

6. Reynoso C. Complejidad y caos: Una exploración antropológica. Buenos Aires: SB; 2006.

7. Watts D. Seis grados de separación: La ciencia de las redes en la era del acceso. Barcelona: Paidós; 2006.

8. Díaz Córdova D. Antropología alimentaria de la Quebrada de Humahuaca: Modos de producción, patrón alimentario y sus efectos sobre el cuerpo y la salud de la población quebradeña. [Tesis de Doctorado]. Buenos Aires: Universidad de Buenos Aires; 2015.

9. Muscio H. Colonización humana del NOA y variación en el consumo de los recursos: La ecología de los cazadores recolectores de la Puna durante la transición Pleistoceno-Holoceno. Naya [Internet]. s/f [cited 10 Jul 2016]. Available from: http://tinyurl.com/hm5kngw.

10. Reboratti C. La Quebrada: Un estudio geográfico, histórico y social de este Patrimonio de la Humanidad. Buenos Aires: La Colmena; 2003.

11. Antropocaos. Exploraciones en antropología y complejidad. Buenos Aires: SB; 2009.

12. Reynoso C. Redes sociales y complejidad: Modelos interdisciplinarios en la gestión sostenible de la sociedad y la cultura. Buenos Aires: SB; 2011.

13. Wasserman S, Faust K. Social networks analysis: methods and applications. New York: Cambridge University Press; 1994.

14. Wolfram S. Cellular automata. Los Alamos Science. 1983;9:2-21.

15. Schelling T. Models of Segregation. The American Economic Review. 1969;59(2):488-493.

16. Schelling T. Dynamic models of segregation. Journal of Mathematical Sociology. 1971;1:143-186.

17. Sakoda J. The checkerboard model of social interaction. Journal of Mathematical Sociology. 1971;1:119-132.

18. Epstein J, Axtell R. Growing artificial societies: Social Science from the Bottom Up. Washington DC: Brookings Institution Press; 1996.

19. Centre for Interdisciplinary Science. Complex Systems-Sugarscape [Internet]. University of Leicester [cited 10 Jul 2016]. Available from: http://tinyurl.com/z6k34os.

20. Bourdieu P. Razones prácticas sobre la teoría de la acción. Barcelona: Anagrama; 1997.

21. Giddens A. La constitución de la sociedad: Bases para la teoría de la estructuración. Buenos Aires: Amorrortu; 2006.

22. Aguirre P. Estrategias de consumo: qué comen los argentinos que comen. Buenos Aires: Miño y Dávila; 2015.

23. Eglash R. African fractals: Modern computing and indigenous design. New Brunswick: Rutgers University Press; 1999.

SALUD COLECTIVA. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008

**CITATION**
Díaz Córdova D. Methodological novelties applied to the anthropology of food: agent-based models and social networks analysis. Salud Colectiva. 2016;12(4):635-650. doi: 10.18294/sc.2016.1008.

Received: 13 June 2016 | Modified: 22 September 2016 | Accepted: 16 November 2016



http://dx.doi.org/10.18294/sc.2016.1008

The translation of this article is part of an inter-departmental and inter-institutional collaboration including the Undergraduate Program in Sworn Translation Studies (English< >Spanish) and the Institute of Collective Health at the Universidad Nacional de Lanús and the Health Disparities Research Laboratory at the University of Denver. This article was translated by María Laura Colin and Daniela Sindoni, reviewed by María Pibernus and modified for publication by Emily Leeper under the guidance of Julia Roncoroni. The final version was approved by the article author(s).