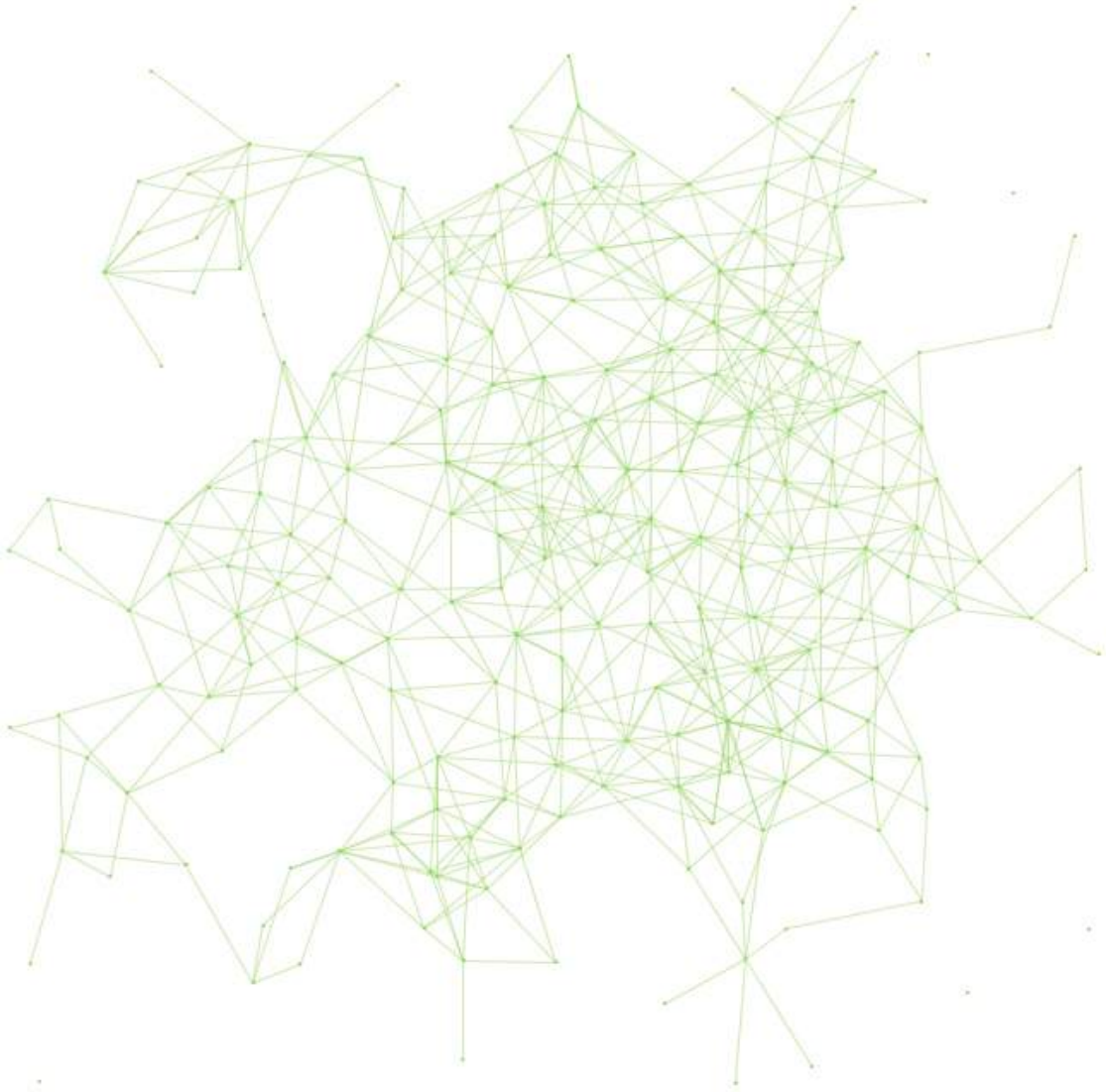
F.XIV

Forma 14 II edition

workshop

FORMA'14
Complex Systems Workshop
ISBN: 978-84-617-9075-3
Editorial: Fidetia (Sevilla)
Editado por: Jaime de Miguel Rodríguez
Con: Departamento de Ciencias de la Computación e Inteligencia Artificial de la Universidad de Sevilla y Culturadigital
Formato: Digital, Descarga
Fecha de aparición: 30/06/2015

http://forma.culturadigital.cc
info@culturadigital.cc
@cultdigit



I. The Workshop

WHAT IS FORMA?

FORMA is an initiative to promote agent-based thinking among researchers from every single discipline such as art, biology, maths, sociology, economics and urbanism. Agent-based systems are used to study complex realities, which can hardly be shaped by traditional methods. The aim of this special event is therefore, to provide participants with a solid agent-based modelling expertise that will enhance their understanding of complex processes within their field of research.

The workshop is organized around a limited number of case studies, selected among proposals submitted by researchers from all over Spain. Each case study has a clear target to be addressed during the three full-days of the event, and the authors of the proposal are assigned an agent-based modelling expert plus a team of students, typically from Computer Science and Mathematics, that are in the process of developing modelling skills.

***

Forma provides an interdisciplinary space where students can work together to solve real problems, while researchers from any field meet the opportunity to work hand in hand with highly skilled programmers towards their research targets. This event unfolds as a great networking tool, where minds with different assets meet to pursue common interests. After this first edition, many of the teams have continued developing their models, or established other kinds of collaboration, even sending abstracts together for international conferences etc.

Apart from the "hands-on" work, the workshop includes top level speakers from the European Network for Social Intelligence, as well as daily tutorials on "soft-learning-curve" languages for agent-based modelling, such as NetLogo, and also Processing. Researchers with no previous knowledge of these tools, will develop enough understanding to prototype new case studies in the future through agent-based modelling, even if only conceptually.

OPEN CALL AND SELECTION PROCESS

In this second edition, a total of ten proposals were received, from which a total of seven were selected, leaving out only three proposals that were too broad for the scope of the workshop or not aimed at agent based systems.

The communication strategy of the open call for proposals, being the second edition of FORMA, was mainly channelled via mailing lists of the major universities in Andalucía and other important universities in Spain. Four of the selected proposals had some connection to the University of Seville, followed by University Pablo de Olavide (1), University of Granada (1) and Central University of Ecuador (1).

Other digital channels like twitter were used intensively to spread the call for proposals and participants.

SELECTION CRITERIA FOR CASE STUDIES

FORMA is targeted towards studying complex processes by means of agent-based modelling. The criteria followed during the selection of case studies in this edition have been:

- **Contemporary subjects:** The case study shall address a topic along the lines of the new information paradigm, digital societies, technological advances and other subjects in which network behaviour plays a decisive role.
- **Complex processes:** Models should aim to clarify a well-defined phenomenon, which due to its inherent complexity requires advanced computational techniques and an interdisciplinary approach.
- **Spatial interaction:** The workshop targets the study of complex processes in which spatiality, be it literal or abstract, has a strong influence over the behaviour of the system at play.
- **Visual understanding:** Proposals shall request for results that can be directly communicated through a graphic visualization of the model and be easily understood by all audiences.
- **Clear identification of the problem:** Because of the limited time to develop the models during the workshop, it is fundamental that a key question is clearly identified in the author's proposal.

CASE STUDIES SELECTED

N1. Leisure Village
Correspondance author: Alberto de Austria Millán

N2. Hosting capacity of el Palmar de la Frontera
Correspondance author: Antonio Piñero Valverde

N3. Evolution of human cooperation and violence: the origin of metapopulations and socio-economic networks within prehistory
Correspondance author: Daniel García Rivero

N4. Pedestrianization of the historical centre of Quito. a way to the conservation of the cultural heritage
Correspondance author: Elizabeth Regalado Bolaños

N5. Metropolitan expansion and mobility in Andalucia
Correspondance author: Gwendoline de Oliveira Neves

N6. Electorate behavior during 2004 Spain elections
Correspondance author: José Luis Sáez Lozano

N7. Coupling between messenger rna synthesis and degradation during genome expression
Correspondance author: Sebastián Chávez de Diego

*N=NetLogo, P=Processing

TEAMS & ORGANIZATION

Once the case studies were selected, one month prior to the workshop, a brief documentation explaining each proposal was uploaded to the website. Then, all participants were invited to fill in a form via email indicating three of the selected case studies ordered by preference, and also, a short note on their background. With that information the organization distributed the participants in teams of 4 to 8 members per team, and assigned a modelling assistant to each one of them as well. Every participant was informed of the team they had been assigned to beforehand.

The workshop opened on Wednesday 22th Oct, 5.00 pm with a short introduction. Then followed a lecture by Joaquín Borrego Díaz introducing agent based modeling. And finally, a round of ten-minute presentations of all the proposals, carried out by their respective authors.

Next day kicked off at 9.00 am with a lecture by Fernando Sancho Caparrini, suggesting the ODD(SEA) protocol as a means to create a common understanding between researchers and technical modelling experts. Afterwards, teams started working on their proposals until evening, first addressing the main features of the model on a conceptual level, and then outlining the structure of the code itself (teams were asked to write an ODD(SEA) protocol and to design work-flow diagrams of their models before actually coding them). Modeling assistants had the task to lead and work hand in hand with all team members. Directors performed individual desk-critics with all teams throughout the day. During the first half of the day, there were two parallel programming sessions of two hours each, to introduce Processing and NetLogo to those participants who had no previous experience with either of the two languages.

The third day, Friday 24th, opened with another (morning) lecture by Fernando Sancho Caparrini, looking into real applications of agent based modeling. The rest of the day unfolded quite like Thursday, including the two-hour programming sessions, working in teams (now focusing on code development) and desk-critics.

Finally, on Saturday 25th, there was a last lecture by Gonzalo A. Aranda Corral around the potential of JADE. Afterwards, all teams presented the results of their models throughout the morning, and by the end of the last presentation there was a discussion session and debate which marked the end of FORMA14.

CREDITS

Organized by:

- Culturadigital
  http://culturadigital.cc
- Chair of Computer Science and Artificial Intelligence, Universidad de Sevilla
  http://www.cs.us.es

Collaborators:

- Chair of Information Technology, Universidad de Huelva
  http://www.uhu.es/dti/

Support:

- eCompleXcity Project TIC-6064
  http://ecomplexcity.org
- Fidetia

Directors:

- Joaquín Borrego Díaz. Chair of Computer Science and Artificial Intelligence, Universidad de Sevilla
- Fernando Sancho Caparrini. Chair of Computer Science and Artificial Intelligence, Universidad de Sevilla
- Gonzalo A. Aranda Corral. Chair of Information Technology, Universidad de Huelva

Coordination:

- Jaime de Miguel Rodríguez
- Ismael Domínguez Sánchez de la Blanca

Modeling assistants:

- Juan Galán Páez
- David Solís Martín
- Yago Fernández Rodríguez
- Francisco Romero Campero
- Jesús Horno Cobo
- Fernando de la Matta Martín
- Angel Linares García
- Teodoro González Manchón
- José Manuel Camacho Sosa
- María Eugenia Villafañe
- Jaime de Miguel Rodríguez

Graphic design:

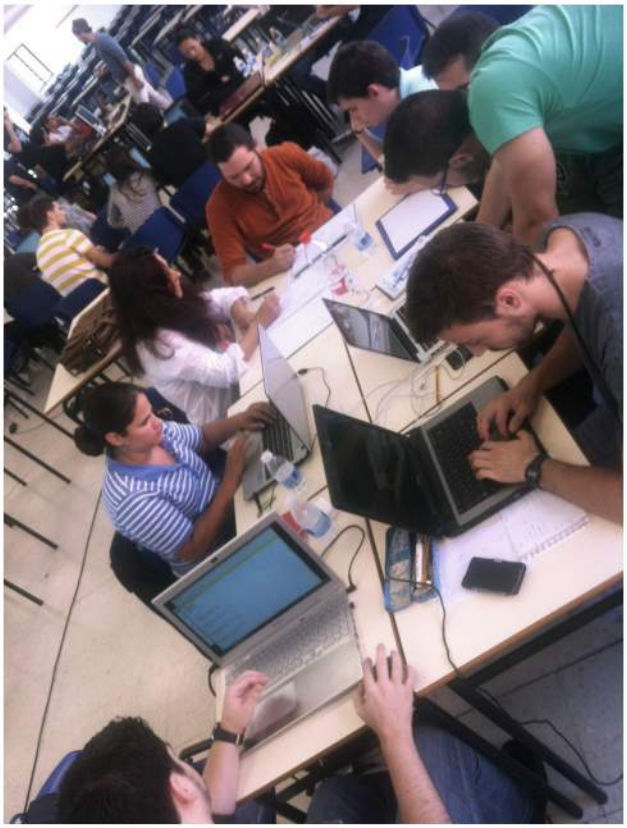
- Javier Aldarias Chinchilla

Special thanks:

To all the persons not listed above, involved in the coordination of the event, and to all participants, especially students, whose enthusiasm and commitment gave life to the second edition of this workshop.

PARTICIPANTS

- Alberto De Austria Millán
- José Manuel Camacho Sosa
- Adrián Jiménez Parrilla
- Carlos Falgueras García
- Cristian Naranjo Marín
- Pablo Canseco Ortiz
- Juan Manuel Macías Bernal
- José Manuel Martín Amate
- Javier Antonio Nisa Avila
- Antonio Piñero Valverde
- Irene Luque Martín
- Gonzalo A. Aranda Corral
- Daniel Corzo García
- Guillermo De La Cruz Dorado
- Vanessa Chipirrás Navalón
- David Sanchez Martínez
- Paloma Rubio Rodríguez
- Enrique Soler Santos
- Myriam Gonzalez Limón
- Daniel García Rivero
- Juan Galán Páez
- Daniel Jurado Sánchez
- Francisco José García Gómez
- Rafael Gómez Galbarro
- Aline Lara Galicia
- Antonio Paredes Moreno
- Francisco Perfectti
- María José Chávez De Diego
- Pedro Ros Reina
- Iván Medina Carranco
- Zoila Ruiz Chávez
- David Solís Martín
- Francisco Manuel Sánchez Castillo
- Juan Luis Sánchez Fuentes
- Andrés José Prieto Ibáñez
- Pablo Martín Muñoz
- Jose Miguel Hernández Segura
- Juan Francisco Ojeda Jiménez
- Alejandro Romero Reche
- Mónica Rueda García
- Claudia Hurtado Rodríguez
- Gwendoline De Oliveira Neves
- Jesús Santiago Ramos
- Teodoro González Manchón
- Yago Fernández Rodríguez
- Adrián Jiménez Parrilla
- Carlos Falgueras Garcia
- Francisco Jose García Gómez
- Jose Nuñez Porras
- José Luis Sáez Lozano
- Jesús Horno Cobo
- Alejandro Labrador Ledesma
- Angel Luis Hans Siria
- Javier Atoche Ortega
- Jessica González Sáenz
- Jorge Calvo Martín
- Antonio Paredes Moreno
- Noelia García Estévez
- Xavier Seguí Salom
- Sebastián Chávez
- Francisco Romero Campero
- Daniel Corzo García
- Daniel Jurado Sanchez
- Francisco Javier Boza Farrán
- Juan Carlos Cuerda López
- Juan Luis Sanchez Fuentes
- Pablo Canseco Ortiz
- Concepción García Vidal
- Pablo Vargas García-Donas
- María Eugenia Villafañe
- Fernando de la Matta Martín
- Angel Linares García



II. Results

N1. LEISURE VILLAGE

Author:
Alberto de Austria Millán - Cerojugadores
alberludo@gmail.com

Collaborators:
José Manuel Camacho (lead) - Universidad de Sevilla
Adrián Jiménez Parrilla
Cristian Naranjo Marín
José Manuel Martín Amate
José Miguel Hernández

Brief: Traditionally, the information that has been offered as support for urban designers was organized like a sum of active legislation, in the form of ordinances, contexts defined by contour lines and a few social statistics, in their best option. This situation has generated a set of unilateral decisions which in many cases led to processes of social disease.

To reach the potential on the practical field, it is essential to understand the position of the new multi-agent design tools, those that make up the full capacity of a programming language within a social study.

The control over these could help for a radical expansion around the intermediate data in the moments that are mixed with the decision making. Just in this moment when a crossed information is necessary, by its implications, also incorporating methodologies with a sensitive feedback, open to its evolution in time and, above all, transparent. The design process starts, therefore, in the composition of the working machine itself.

In this experiment our objective will be to bring on abstract cities by their essential uses, the statistical behavior of inhabitants with different affinities for these specific areas. The behavior of the whole, and its sustainability over time, and the consequences generated by each family will provide us a complex data on the spatial study of urban environments.

Key question: Is there a virtual analogy to visualize the causes and consequences of birth and death of cities?

ODD Protocol:

1. PURPOSE

What is the purpose of the model?

The study of the dynamic location areas and residential uses in a generic urban environment through the affinities of a set of different families.

For what purpose has it been developed?

To expand the data field on the city by designing a tool of multiagent calculation.

What are you going to use it for?

To find the different inhabitant satisfaction degrees, and its evolution, in some initial distributions of uses of space in the city. In other words, improving levels on generic predictive values of the city, built or under construction.

2. ENTITIES, STATE VARIABLES AND SCALES

What kind of entities compose the model (agents / individuals, spatial units, environment, communities)?

We use 5 different patches based on the simplified use of the urban environment. 4 initials:

- Crops (Parks & public spaces)
- Public service

- Production
- Tertiary sector

And a fifth consequent from the movement and individuals actions.

- Building

5 turtle agent define 5 different affinity for each of the patches.

- Family 1
- Family 2
- Family 3
- Family 4
- Family 5

What internal state variables or attributes characterize such entities?

The patches contain a state variable: "valid" or "invalid"

Turtles have a state variable "happy" or "unhappy"

In what unities such variables or attributes are expressed?

The affinity gradient is between 0 and 3. The minimum threshold of happiness / unhappiness was calculated from the sum of weights referring to the number of patches with such affinity.

The valid / invalid concept is defined in each patch in question, asking if it is in the field of affinity of at least one turtle.

The consequence patch (building) will be considered valid / invalid if at least it has = 1 individual above it.

What is the spatial and temporal extent of the model?

Spatial extent is a square 81x81 cells.

The temporary extension is decomposed into 50 ticks-series when each family with happiness, generate a new offspring. There is no limit of time. That happens when the population becomes extinct.

3. SUMMARY OF PROCESS AND PLANNING

Which entity does what?

Families (turtles) seek happiness. Zoning (patches) are optimized for utility. The building (patch) attracts families from t> 0.

In what order the different processes run?

1. Initial Process: The uses are generated within the limits of the world, except for the houses, and following a project percentages established. The percentage distribution of n families (turtles) of each type is randomly generated.
2. Initial phase Process: With each tick, it occurs the families' movement searching for an optimal location
3. End-phase Process: Families that are happy will multiply and will modified the patch under them transforming it in buildings if they do not die for their ages.
4. Standard phase process: Both families, the happy ones and the descendants from them, with each tick, they will gonna seek a new optimal location.

   [After that We're going to repeat the loop "end phase" - "standard phase" until the end of the experiment]

In what order various entities running the same process?

1. Initial process:
   - Deployment of patches

- Deployment of turtles

2. Initial phase Process:
   - All turtles at a time on each tick, check whether they are "happy" with their affinities and, if it doesn't happen, They turn around and take a step forward, whose length could be edited, searching for its optimum location.
3. d-phase Process:
   - The Turtles (families) who have found their optimal location transform the patch where they are like "house" and they create 0-3 new agents.
   - The Turtles (families) who have not reached their optimal location on the limit of ticks, they disappear from the framework.

How is the time modeled?

By discrete steps or as a non-stop temporary process in which both continuous processes as discrete events occur?

Everything discreet.

4. DESIGN CONCEPTS

4.1. Fundamental principles:

What concepts, theories, theoretical assumptions underlying the design of the model?

The model is complex enough to accommodate different theoretical conceptions. We could group hypotheses and concepts around three main areas:

- ARCHITECTURE AND TECHNOLOGY
  - Focus the view on immersion of generative calculation tools in data generation processes.
  - The limits in our relation with the tools, the machine and its conclusions.
  - Game theory as a deliberate intention. Working with the concepts of survival / simulation / evolution / model.
- DESIGN / (NO) VISUALIZATION
  - Open Hardware. Hierarchy knowledge / participation
  - Multidisciplinary complex processes
  - Intentions of learning and not to categorize or colonize from one discipline.
  - Alternative representations for design problems. More interesting than the old representations, especially in the overall planning.
- CITY SCALE
  - Geometrical and topographical relationship.
  - Multiple uses relationship.
  - Inhabitant ratio (Working with different types of inhabitant with affinities)
  - Time relationship

What modeling strategies underlie in the same design?

Field of continuous patches, forming a torus, and with no limitation of time ticks. The pattern is repeated until it is extinguished. An alternative to the bounded representation.

The distribution of families across 5 different types of turtles agent affinities.

What is the relationship about these assumptions in the purpose of the study?

The "generic" relationship of the model fits with the configurations without spatial / temporal limits for the model: Everything would be possible, the forecasts and the analyzes of the built.

The different affinities relationship is clear: we try to simulate, albeit in a simplified manner, the relationship of the inhabitants with the different areas of the city, which is different depending of each group of individuals.

Are they used at the level of the sub-models (as microfundamentales hypothesis) or

system level (as macrodynamics theories)?

These features directly influenced by the theories fit into the macro configuration.

Will the model provide the evidence on these fundamental principles, such as its scope, its usefulness in real scenarios, validation or indications for modification?

The translation to the potential scenarios becomes real . Similarly we can work on generic aspects with a set of random patches, we could set a particular context importing a patches mesh preset according to a city study or a development plan.

Do you use consolidated novel theories or model?

The project wanders between different concepts. On the one hand the classic study of natural forms and developments of the city, social parameterization and its symbiotic relationship with each of the zoning. Furthermore, the relevance of including these dynamics within the broad spectrum of the new science of cities, where from the calculation through the new tools, we can get extended data.

We could therefore quote a basic bibliography:

- Christopher Alexander: Language patterns.
- Michael Batty: The new science of cities.
- David Grahame Shame: Urban Design since 1945.
- Kevin Lynch: The good shape of the city.
- Jane Jacobs: Death and Life of Great American Cities.

4.2. Emergency:

Which results in the model are expected to vary in complex ways and perhaps unpredictable inside a change of the particular characteristics of individuals or environment?

Especially the distribution in the patches, as an end itself. Another full and unpredictable result would be the total life of the whole population, or its fluctuation in time.

What model results already imposed by the rules and therefore less dependent on the behavior of individuals?

A crucial part of the origin of these results is the rule that impose the replacement of buildings "abandoned" by the common use around each patch.

4.3. Adaptation:

Which adaptive traits have the individuals?

Each turtle has adaptive capacities. This occurs from two views:

- a. A collective vision: At the end of each stage if the turtle has been happy generates a new family with kinship.
- b. An individualistic view: At the end of each phase its happiness is rechecked about their changed environment.

None of these changes occurs in the agent itself.

Which rules do they have to make decisions or change their behavior in response to changes in themselves or in their environment?

In their relationship with the environment, we will handle a variable threshold for happiness that will determine the dynamic behavior of the turtle with the patch.

In connection with its offspring, the options are equitables to generate the same or directly adjacent types. (Eg. If your type is 1, you can only generate 1 or 2)

Do these features try to increase some kind of indicator of individual success related to its objectives? Or just the individuals reproduce certain behaviors that are implicitly

assumed to be conducive to success or adaptation (eg, "scroll right 70% of the time")?

We could consider an indicator of individual success if this process of natural adaptation achieves to extend the life of the whole set. An equitable distribution of areas or types of family values could also be useful in this trial. True, this is the result of repetitive actions that supply the data from their combination over time.

4.4. Objectives:

What are the objectives individuals through adaptive processes that govern their behavior?

Be happy, build a home (building) and generate offspring.

How can we measure these objectives, as well as their compliance?

We can know the statistics of happiness and the number of new individuals / houses for each phase.

Which criteria use the individual agents to evaluate alternatives when they have to make decisions?

Its dynamic in the world will come depending on the distribution of own affinities of its kind.

4. 5. Learning:

Do they change adaptive traits over time as a result of the experience?

Not by the agents.

Are they aware of changes, including planned or are simply responses to a changing environment?

They are simple answers. The only planning agent corresponds to the observer.

4.6. Prediction:

There is not predictive capabilities within the actors in the model.

4.7. Perception:

What state variables, internal or the environment, it is assumed that agents perceive?

The turtles perceive the type of plot (patch) in an editable radio. Building plots perceive the number of agents in its location.

What measurement models are used by the agents for this perception?

Turtles have a system of weights according to affinities. The building cells perceive the number of agents.

What is the scope of the signals that an agent can perceive, local or global?

The radius of the turtles is in a local scope and it can be edited. For the scope of the building it will obviously limit by its borders.

4.8. Interaction:

What types of interactions are assumed to be relevant between the agents?

The optimal combination of patches for each agent turtle, causes it the stop at the proper location. Conversely if the turtle does not find the optimal place in the patch it will continue moving. The stay at the end of a phase above any cell causes its change into edification. If It keeps moving without solution for a complete phase it causes the disappearance of the turtle. The absence of new users in an already built cell, causes it the incorporation to the remaining patches with a random use based in the most common uses.

Is there direct interactions, as if the encounters between agents influence over them?

The one that came from the process of building construction and their subsequent destruction.

Is there indirect interactions, as if competing for an intermediate resource?

Yes, the combination between the patches and the turtles' needs indirectly influences the options of happiness of them.

4.9. Randomness:

Which processes are modeled assuming they are fully or partially random?

On a percentage basis, the placement of the initial state of the zones is done randomly. (Exclude in this set the cells "houses") This is done through an editable number of area generators.

Placing the turtle agents (people) on the map in the initial state is random.

The position of the descendants, althought it is conditioned within a patch around the parent, it is done randomly.

The movement of the turtles and their degree of rotation is also random.

The number of offspring, although limited beetween 0-3, is random too.

The type of offspring also has a degree of randomness, always if it fits any 0-1 degree of separation from the father.

Does the randomness use to generate variability in processes for which it is not considered important to model their causes?

We can consider that the placement of both turtles and patches, do not have a significant causality.

Randomness is used to generate events or behaviors that occur at a specific frequency known?

The degree of randomness from the number of descendant, offspring type and position of these have, within limits, a known frequency that we try to use.

4.11. Observation:

What data are generated and collected from the simulation for analysis?

- Number of happy agents.
- Number of unhappy agents.
- People who leave the model.
- People who die.
- Houses built.
- Number of People.
- Number of family type.
- % By family type.

How such data are collected, and at what time or times?

At the end of each tick the data is collected. Although values that do not change until the end of each phase (eg. number of houses) do not show any change in the regular ticks.

Are all the data generated used, or just a sample, in imitation of what usually happens in an empirical study?

Everything is used.

5. INITIALIZATION

What is the initial state of the model, that is, at time t = 0 of the simulation run?

The initial phase is the tick = 0, with the distribution of patches and turtles.

How many entities are in the virtual society initially, and what values, accurate or random distribution, are the state variables of the entities?

Two, patches and turtles. The patches are distributed within a framework of 81x81. The percentage allocations of the 4 zones, and the number of these generators are set in editables input scrolls. The place of the generators and the growth of the turtles at this stage is done with a random distribution. The initial orientation of these turtles is also random about its 360 degrees of rotation.

Is it always the same or may vary between different runs of the simulation?

We can vary completely while respecting the limits.

Does the initialization corresponds to a state of the real world, that is, is empirically calibrated (data-driven), or the values are arbitrary?

They are totally arbitraries, although its boundaries have some inspiration in the real world. Also they are considered as editable enough to allow adaptation to real values.

In the case of the initial values of the affinities of each type of family, this simulate a simplification of a social study help by psichologist envolved in the experiment.

6. DATA ENTRY

Does the model use data from external resources (data files, or other models) to represent processes that vary in time during the simulation?

No. Although It admits this entry.

7. SUBMODELS

How are they been designed or selected such models?

As part of joint variables within the possibilities of the tool created.

From which other systems are this models "extracted" or "inspired" for current use?

From different possible urban experiences. We have moved these initial values from the real values to the possibilities in the tool.

8. SIMULATION AND EXPERIMENTAL

Which experiments can prove the validity of the model?

In our case we have designed four experiments, within some intentional premises:

- Case 1
  - Standard Home
  - Prediction of a smooth curve population
- Case 2
  - Intitial Crop affluence
  - Fast development process
  - Prediction of a big city, controled by the urban families and soon fall
- Case 3
  - Nearsightedness families
  - Prediction of small towns (but really dense)
  - Withouth a correct replacement of uses, the final map will not have relevant data
- Case 4
  - Big Scale Project, inspirated by the author
  - Great initial competition
  - Confuse Prediction

- A coherent replacement of uses will generate an helpful final map

Which parameters from the model should be modified (and for what range of values) to check model behavior?

- Case 1
  - Population: 400
  - Threshold: 15
  - Vision-people: 25
  - Radio-ext: 1.4
- Case 2
  - Population: 150
  - Threshold: 20
  - Vision-people: 25
  - Culture: 50%
  - Services: 13%
  - Production: 13%
  - Tertiary: 13%
  - Radio-ext: 1.4
- Case 3
  - Population: 350
  - Threshold: 40
  - Vision-people: 20
  - Culture: 25%
  - Services: 25%
  - Production: 25%
  - Tertiary: 25%
  - Radio-ext: 1.8
- Case 4
  - Population: 7000
  - Threshold: 35
  - Vision-people: 25
  - Culture: 25%
  - Services: 25%
  - Production: 25%
  - Tertiary: 25%
  - Radio-ext: 1.4

What representations can make from the variables of the study (measurable outcomes) to facilitate understanding of the model?

At a representation level, we work with 3 different graphics:

- Happiness: It shows the lines of happy and unhappy agents over time
- Building: It shows the total number of buildings by turn and over the time.
- Population Development: It shows the total number of agents for each type of family over time.

Did you store information throughout the execution of the model? (Specify which)

Yes. A large amount of data is saved:

- Number of happy agents
- Number of unhappy agents
- People who leave the model
- People who die

- Houses built
- Total People
- Number by family type
- % by family type

9. MODEL ANALYSIS AND CONCLUSIONS

How the model behaves in front of the initial assumptions (known behavior under realistic conditions)?

For each of the 4 experiments indicated, by very different ways:

- Case 1: This first one has behaved in an intuitive way. A smooth growth curve, a stable zenith for 10% of total time and predictable decline even in its process of exchange of roles between families.
- Case 2: In this case, the outcome was much more extreme in many respects. The large initial growth, with an implicit and disproportionate distribution among families, caused an increase in built and, as expected, a large and rapid decline of the whole livable surface. Yet overall survival was greater than in case 1.
- Case 3: In this experiment we had got a similar case like the first one in terms of the numbers of the set data, although the visual representation became really different. The turtles were concentrated in large population nodes. This was maybe the cause of a fall curve of the total population really less smooth than in previous examples.
- Case 4: Its behavior appeared in an unexpected way. After strong initial competition on the first ticks, several self-sufficient communities of the 3 "lower" family classes were generated in different places in the patch. With a very small number of population, about 10 individuals per community, they reach a situation of stability of nearly 10,000 ticks until its extinction.

How does the model behave under unknown conditions?

We have already seen this in the first case, with a random initial data almost entirely.

What possible improvements allowed the model to view the results?

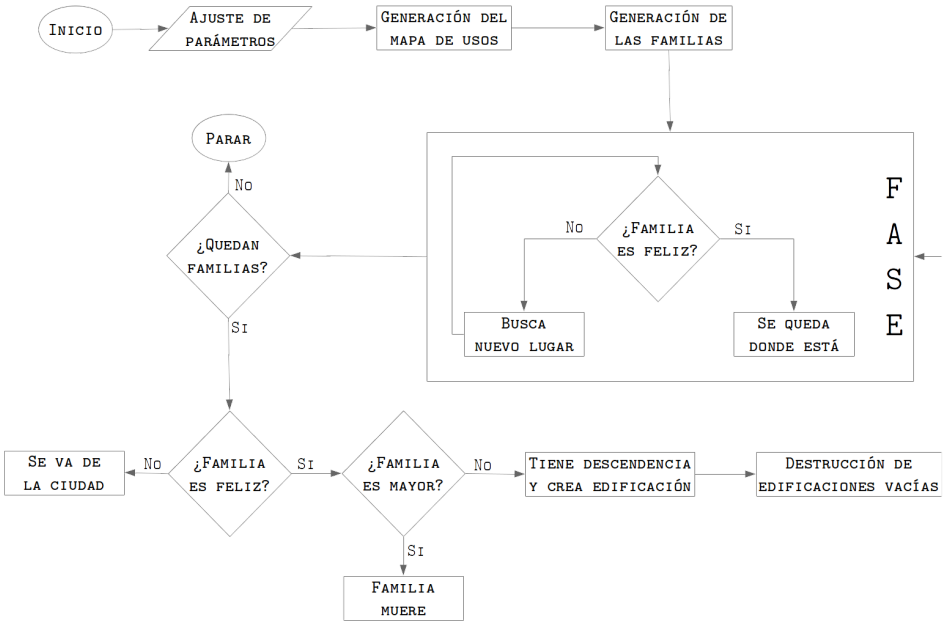
Many of them. If we only think in their incorporation into the infrastructure of work, we could cite a few:

- The incorporation of a transport pattern that help us to check its influence over other areas, not so much as condition for the movement of the turtles, because the concepts and the pursuit of happiness ticks / year do not need them.
- The incorporation of empty areas, ensuring that the perimeters of the urban complexes begin to appear.
- A sample of different values according to the data of occupancy per cell, which in this case we have simplified in a binary level.

What interesting variations could be made?

An interesting variation would deepen a more complete social study. This could be composed in two ways. Detailing more degrees of relationship in families that we have already created, or introducing families not so much in a social class distinction but by other coefficients depending of different ways of life (Age, group work ...)

Flow chart:



Code: N1_code.nlogo
View it on Github: https://github.com/culturadigital/forma14/blob/master/N1.nlogo

Model snapshots:

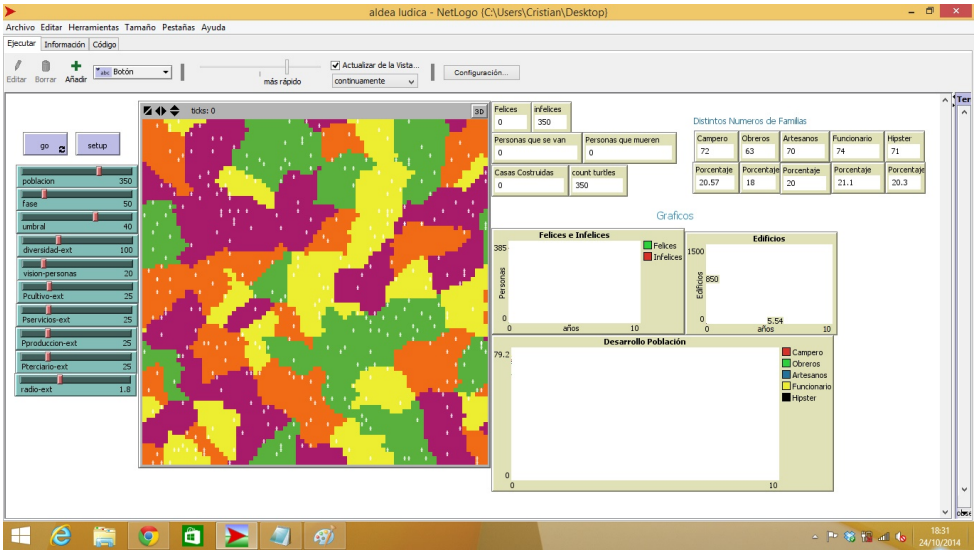


Figure 1. System initialization with a distribution value of 20%

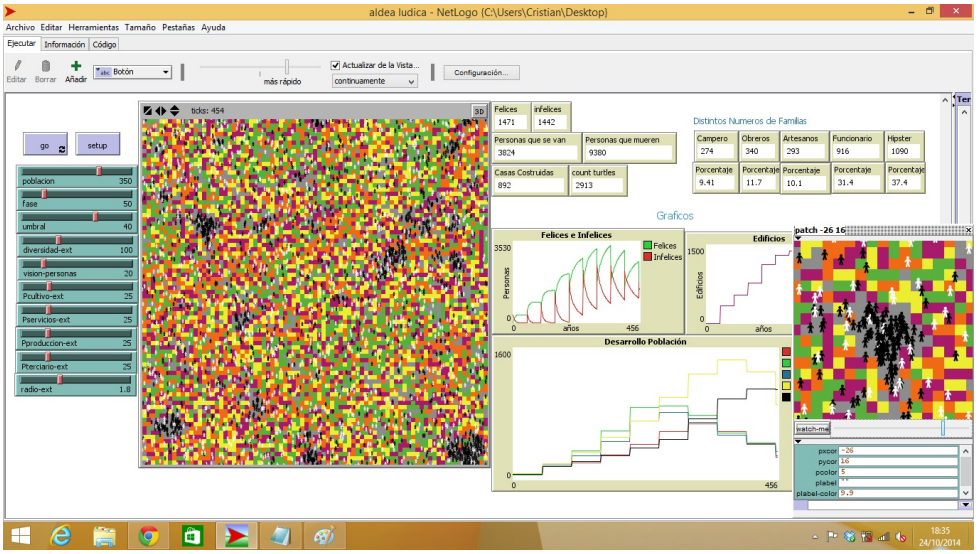


Figure 2. System during development and agglomeration with a distribution value of 20%

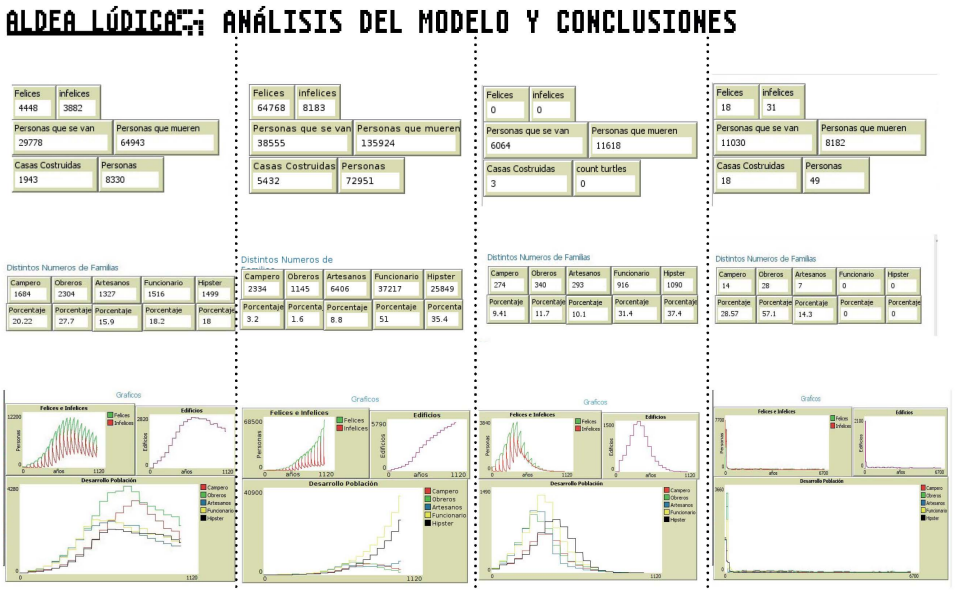


Figure 3. Comparative data analysis of the different scenarios

Results and conclusions:

There are several conclusions. The first one, and the most obvious, appears from the possibilities to translate this tool, using the same arguments but inside a new combinatorial infrastructure, and our capability to carry it to really enthusiastic places. Therefore we conclude that the link between theoretical considerations about urbanism and the results of a complex computation is more alive than ever, embedded in the debate on the position of the machine and its results. The designers find here a path for a further exploration that force us to develop our design tools.

Inside the work developed itself, we can also draw a conclusion about the extremely importance to understand the complexity of the different affinities of the inhabitant, including this like an argument for the hope within urban decisions that can respect some multidisciplinary committees - including sociological - in the think tank groups of the city. For this, the inhabitants analyzed also should be individuals and different, combined and competitive because is the only way to reach a parameter degree about the optimum places.

Finally we found the great value about include the time in the virtual models. For a simulation about an urban complex model, we conclude essential to incorporate a study in time, whatever its development. The city is not understood but as a set of terms, all of them based on the transient. Even with the simplification of our model, it has been tremendously helpful that we could control this factor. We were able to get a certain urban analogies that transcend the model space thanks the time factor from

the different agents and patches.

References:

- Christopher Alexander: A Pattern Language.
- Michael Batty: The new science of cities.
- David Grahame Shame: Urban Design since 1945.
- Kevin Lynch: A Theory of Good City Form.
- Jane Jacobs: The Death and Life of Great American Cities.

N2. HOSTING CAPACITY OF EL PALMAR DE LA FRONTERA

Authors:
Antonio Piñero Valverde - Universidad de Sevilla
anpival@us.es
Irene Luque Martín

Collaborators:
Gonzalo Antonio Aranda Corral (lead)
Daniel Corzo García
Guillermo de la Cruz Dorado
Jorge Calvo Martín
David Sánchez Martínez
Paloma Rubio Rodríguez
Enrique Soler Santos
Myriam González Limón

Brief: The purpose of the model is through the concept of carrying capacity of El Palmar in Vejer de la Frontera, found in the urban planning process: which of the proposals capacity host user creates a better balance between the three principals impacts by an intervention of urban planning: social, economic and environmental impact.

The objective of this model is the approach of urban scale simulation. The process model is divided into two scenarios: baseline to the input data, and execution of 80 ticks which equals the study performed 20 years after ordination. The first is when we select the increase (PI, SI or TI), select whether or not seasonal pattern, and spatial distribution of agents occurs. Once distributed agents begin ticks every four ticks the counter is reset. This means that the occupancy level discussed in previous sections, corresponding to four ticks, so the functions of ticks occur 80 times, but every four ticks are generated different situations because of the 4 quarters of a year. The status of each agent begins execution and occurs in the appended order functions. Once done the whole process, in each graph of the environmental, social and landscape impacts and a joint graph where we see the consequences of proposed urban model.

Key question: What is the optimal hosting capacity of El Palmar?

ODD Protocol:
1. Overview

Purpose: The purpose of the model is, attending to the idea of maximum hosting capacity in Palmar area of Vejer de la Frontera, to shed light on a key question within the planning process: what is the hosting capacity that generates a better balance between the three main layers of impact that unfold from a planned urban intervention; social, economic and environmental?

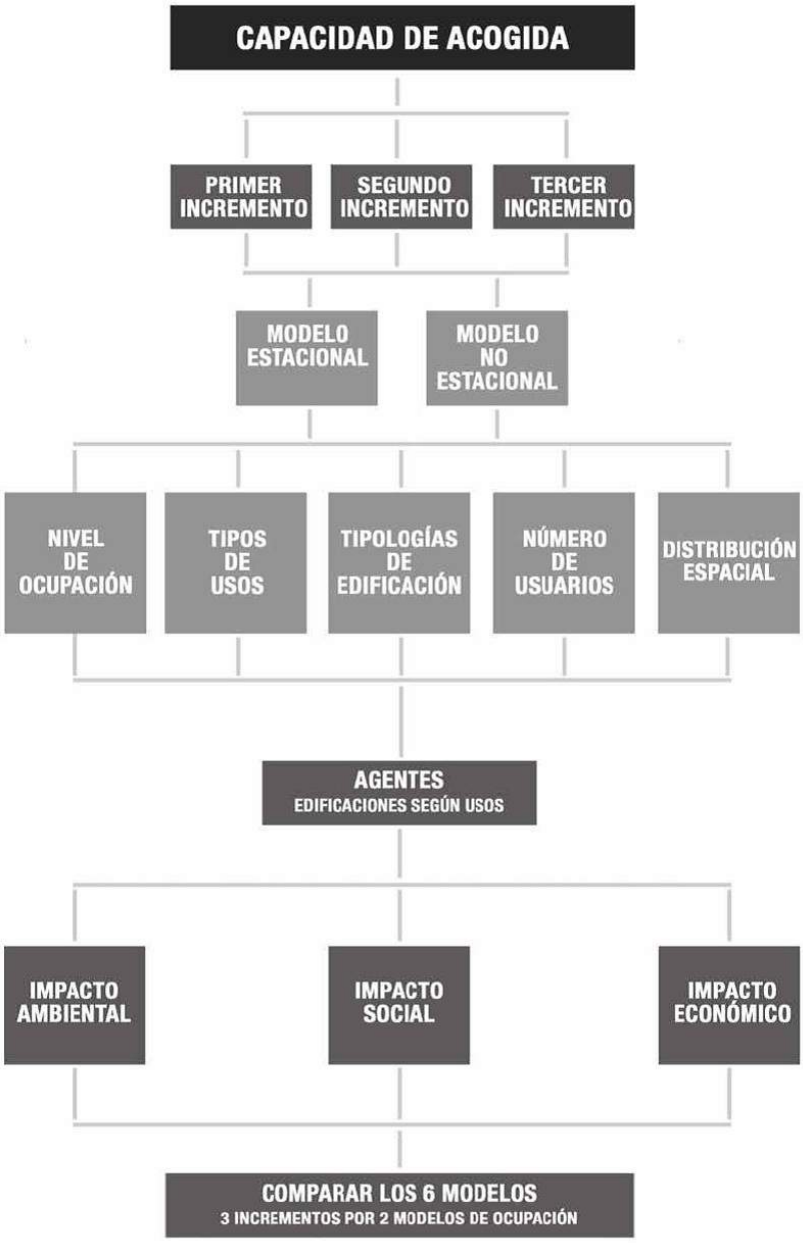


Figure 1. Hosting capacity scheme

The aim of this model is to bring closer the scale of urbanism to the realm of digital simulations. As opposed to other models developed in Spain dealing with the scale of the territory, this model is setup as a potential tool that may go hand in hand with the planning process at its correspondent scale, and also, analysing the impact of the different proposals for intervention. The model does not attempt to predict the social patterns of land occupation but to approximate the planning process by means of pure urban parameters. This way we are dealing with urban simulations only within the scope of the discipline, trying not to step into the field of social behaviour because the discipline from which to approach that level would be a different one.

In short, understanding the urban as a live organism, characterised by behaviour, relationships and interaction patterns, is the objective of the simulation and the results, inserting the urban planning process within the realm of urban simulations.

Entities, state variables, and scales: Entities are agents. Their variables may be global or local. Units are numerical or true-false type. The model is set for 20 years, and the time unit (tick) is equal to 3 months, therefore there will be a total of 80 ticks. The

scale of the model is an urban plot of 546 Ha.

Agent	State variable	Units	Variable local / global /auxiliary
Vivienda	Número de usuarios	Número (0-50)	Local
	Incremento (PI / SI / TI)	Número (1-2-3)	Global
	Estacional	Sí / No_ S/N	Global
	Nivel de ocupación	Porcentaje_%	Local
	Trimestre	Número (1 – 4)	Global
	Disponible agua	Litros_ L	Local
	Disponible saneamiento	Metros cúbicos_ m3	Local
	Disponible energía	Potencia_kw	Local
	Placas solares	Sí / No_ S/N	Auxiliar
	Consumo agua	Litros_ L	Local
	Consumo saneamiento	Metros cúbicos_m3	Local
	Consumo energético	Potencia_kw	Local
	Tipología	Bloque/Adosado/Unifamiliar (B/A/U)	Local
	Agrupado	Sí / No_ S/N	Auxiliar
	Ciclo del agua	Número	Local
	Saneamiento	Número	Local
	Energía	Número	Local
	Movilidad No motorizada	Número	Local
	Impacto funcional	Sumatorio Número	Local
	Tipología y morfología	Número	Local
	Calidad proyectual y constructiva	Número	Local
	Espacio público y arbolado	Número	Local
	Impacto paisaje urbano	Sumatorio Número	Local
	IMPACTO AMBIENTAL	Sumatorio Número	Local
	IMPACTO SOCIAL	Número	Local
	IMPACTO ECONÓMICO	Número	Local
	Número de usuarios	Número (0-300)	Local
	Incremento (PI / SI / TI)	Número (1-2-3)	Global
	Estacional	Sí / No_ S/N	Global

Table 1 (see annex for complete table). Entities and state variables

Process overview and scheduling: The process of the model is divided into two different scenarios: the initial setting with all the data collected from the start, and the the execution of the 80 ticks that correspond to the 20 years elapsed after applying the urban planning.

In the initial scenario we choose the increment (PI, SI or TI), we also choose whether or not the model will take seasons into account, and the agents are deployed in the urban layout. Once the agents are deployed, the timer starts counting ticks, and there is a counter which runs with the timer but is set back to cero after four ticks. This is relevant for example when assigning the degree of land occupation, where every four ticks there are different situations due to the four trimester periods of a year.

The execution scenario kicks-off with every agent and sequentially all the functions related to urban impact are executed. Once the whole process is over, we can observe the consequences of the proposed urban planning through various charts showing the levels of environmental, social and landscaping impact, as well as a global chart where all these variables are observed together.

2. Design concepts

Basic principles: The model is based on the concept of hosting capacity. AS we have mentioned somewhere above, we understand hosting capacity of El Palmar as the degree of suitability of the territory according to the set of activities to be incorporated in the urban planning.

The measuring unit of the hosting capacity is users. The degree of users is what generates the main concept of this simulation model, a concept that becomes an aim: to measure the hosting capacity through a three-level increment of users and identifying through visualization, which is the increment that produces the minimum impact levels.

Because of the specificity of this territory, there is an underlying concept to the real functioning of El Palmar, which is the variation of land occupation during the four seasons of the year. Therefore, the concept and main principle of this model is to

study a total of six models of hosting capacity (three different increments by two seasonal scenarios).

This model faces, as many others, the problem of validation. It does not contain as theory an accurate account of the future consequences of the proposed planning according to the specified urban parameters, but rather an attempt to generate an estimate of what are the most influential elements for a better planning, and most of all, to become a future tool for the planning process, as if it were a game (G. Lobo 2006) that will aid us in experimenting with urban complexity in an easier way. Complexities which to date, are not possible to handle without computational techniques.

Emergence: Being the first attempt of the model, we are not able to foresee emergent results, but we can advance that the complexity of indirect relationships between aspects and concepts of urban impact, is able to generate unpredictable relations among agents, and therefore transform the expected outcomes of the program.

Adaptation: Adaptive traits of individuals are present in terms of proximity, affecting directly the spatial distribution based on distance levels causing agents to modify their behaviour beyond our expectation. As an example, a residential building acting as an agent may change its impact level upon a third tier land occupation increment (TI) assuming it surpasses negative un-motorised mobility levels, on the other hand, may adapt in the sense of being close to open public spaces containing all mobility attractors, reducing impact levels substantially. This would be a case of a contrast agent against what would be more predictable.

Objectives: The aims that the agents pursue through adaptation are based on planned and conscious modifications of their behaviour. What we cannot foresee is what will happen once all the agents set to modify their behaviour simultaneously within a certain range of parameters that they have.

Learning: Not present

Prediction: Not present

During the work at Forma14, it was decided to introduce adaptive values that modify the direct behaviour of the agents. Maximum and minimum values of global impact are defined, which also affect the percentages of increments in land occupation. Therefore there are changes generated in every tick during the 20 year span.

Sensing: Agents can read other agents, their land occupation values, whether they are season-dependant or not, and even their impact levels. This scenario is not yet formulates, but as soon as this first implementation works, agents should be able to learn from the impacts on the urban territory, being able to be affected by them as well.

Interaction: The most relevant interactions between agents are driven by proximity and not-clustering. This is, proximity between agents and diversity of distant agents.

Stochasticity: Randomness is essential in this model, but it is controlled through the specification of ranges. From land occupation levels, availability of water, energy and sewage infrastructure, to the consumption levels of the agents, everything is fixed in specific ranges of values within which every agent will have a random value.

Collectiveness: The only state variable that is affected by collectiveness is "cluster". This means that if an agent is clustered it will affect a state variable of the agent as well as all other agents in the cluster.

Observation: The resulting data will be displayed in a graphic chart, collected statistically throughout the 80 ticks, counting total number of users, and showing the average between the three impact types. The model must run 6 times in order to establish a sensible comparison and thus determining which planning strategy presents less impact levels in the territory.

3. Details

Initialization: The initial state of the model is at t=0, this is, when we link the shape files

of the plots and existing buildings, the intervention area is chosen, increment type is selected, all the agents are deployed in the area, and it has been decided whether or not the model will be “seasonal”.

Input data: The model starts by loading a shape file containing in one layer the existing buildings and in another layer the intervention área. Then this data is converted into netlogo “patches” so that the model can work without linking up to SIG data.

Submodels: Since we are working on a first approximation to model the concept of hosting capacity, we haven’t included any sub-models. However, the main concepts have been abstracted and incorporated in the model.

Flow chart:

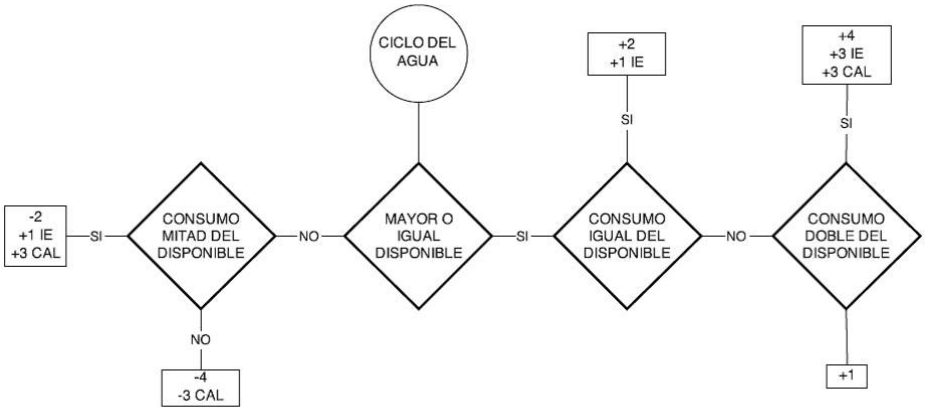


Diagrama de flujos 01. Ciclo de Agua. Abastecimiento. Elaboración propia.

Environmental Impact - 1. Water supply

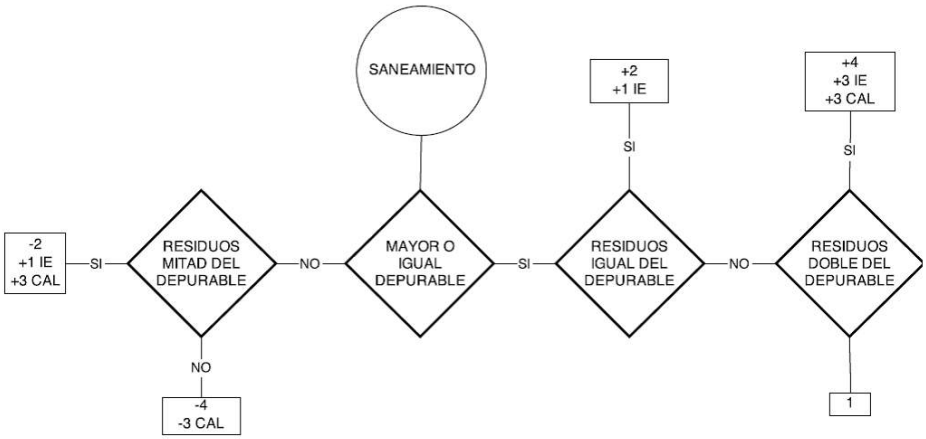


Diagrama de flujos 02. Ciclo de Agua. Saneamiento. Elaboración propia.

Environmental Impact - 2. Sanitation

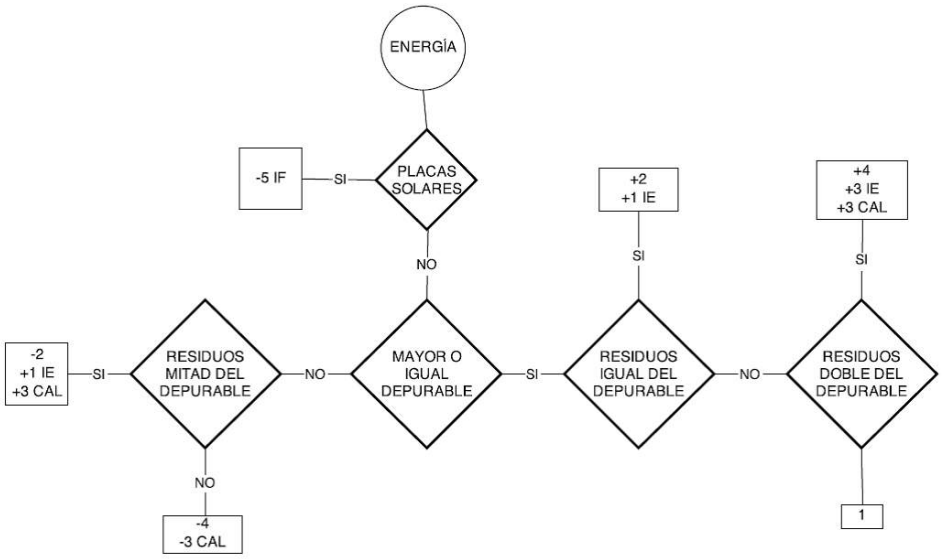
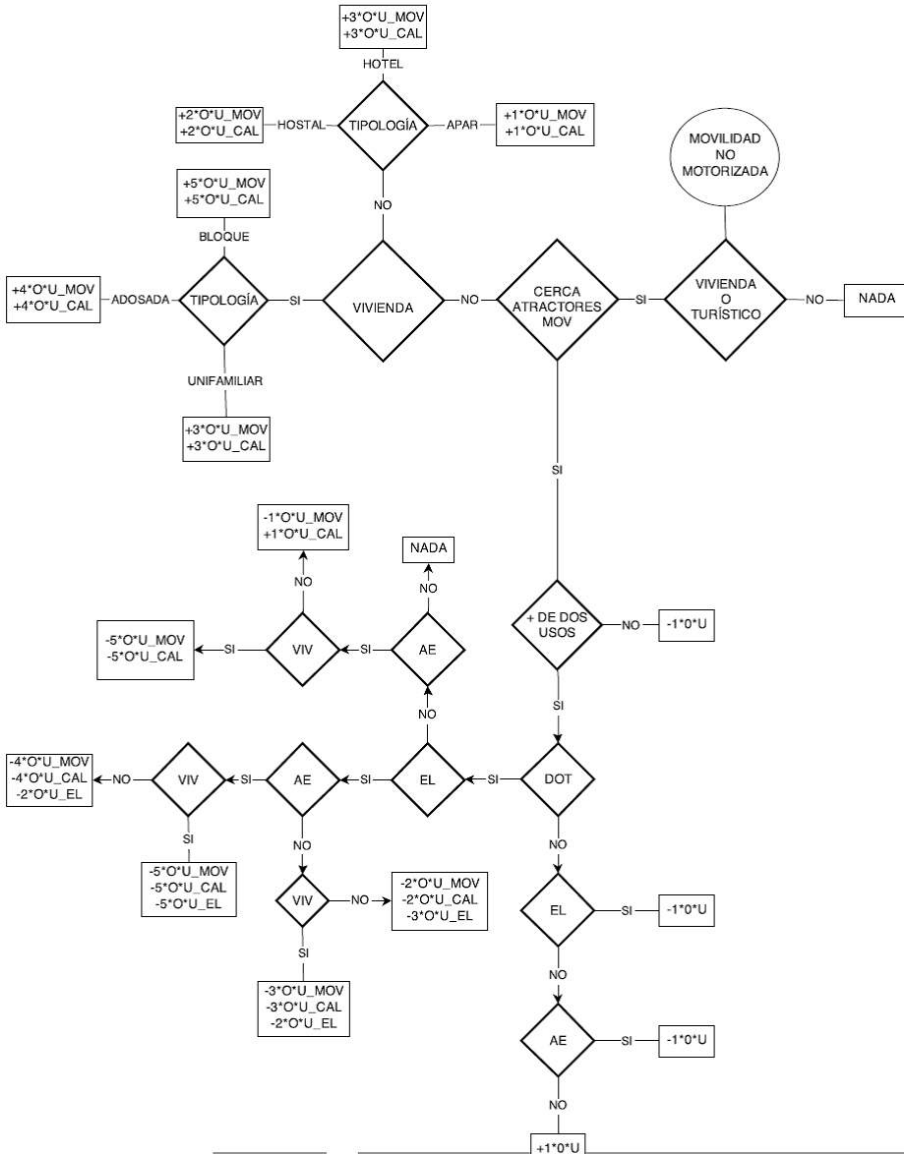


Diagrama de flujos 03. Energía. Elaboración propia.

Environmental Impact - 3. Energy



Environmental Impact - 4. Mobility (motorless)

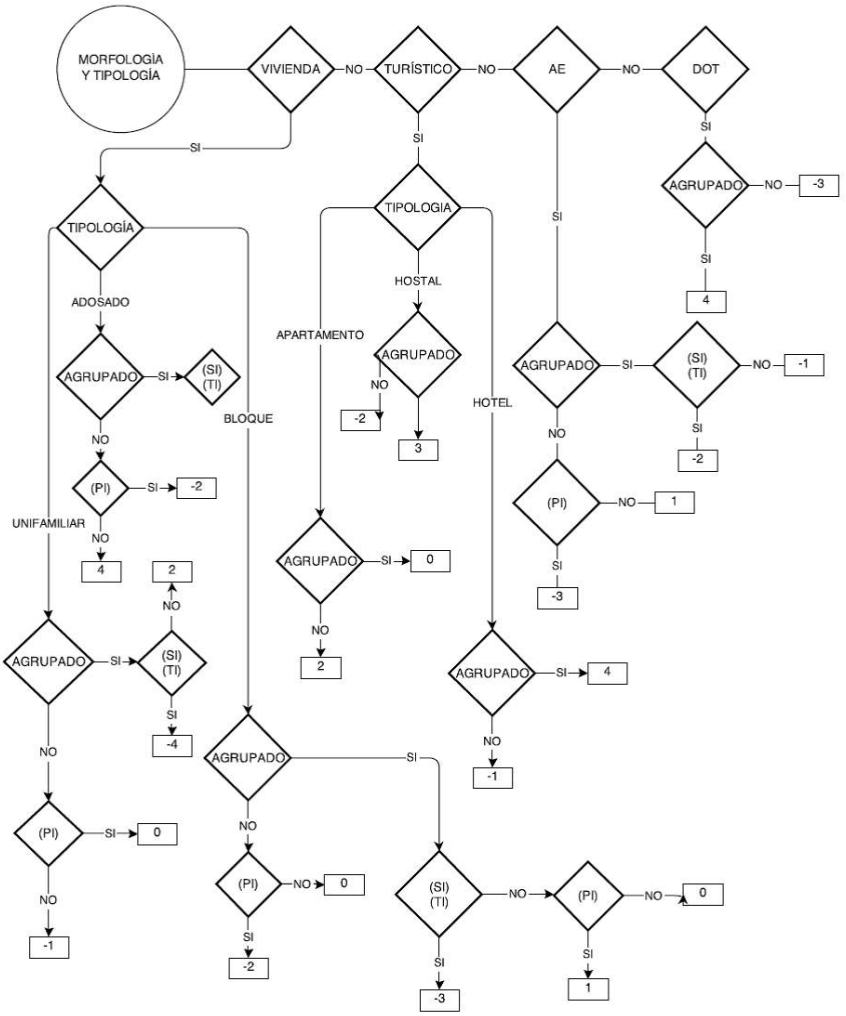


Diagrama de flujos 05. Movilidad no motorizada. Elaboración propia.

Landscape Impact - 1. Morphology and typology

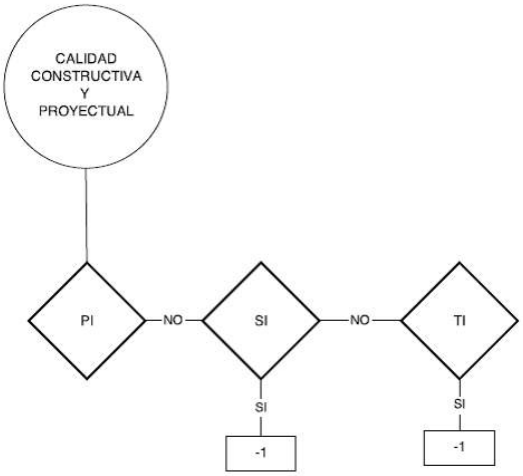


Diagrama de flujos 06. Calidad proyectual y constructiva.
Elaboración propia.

Landscape Impact - 2. Design and construction quality

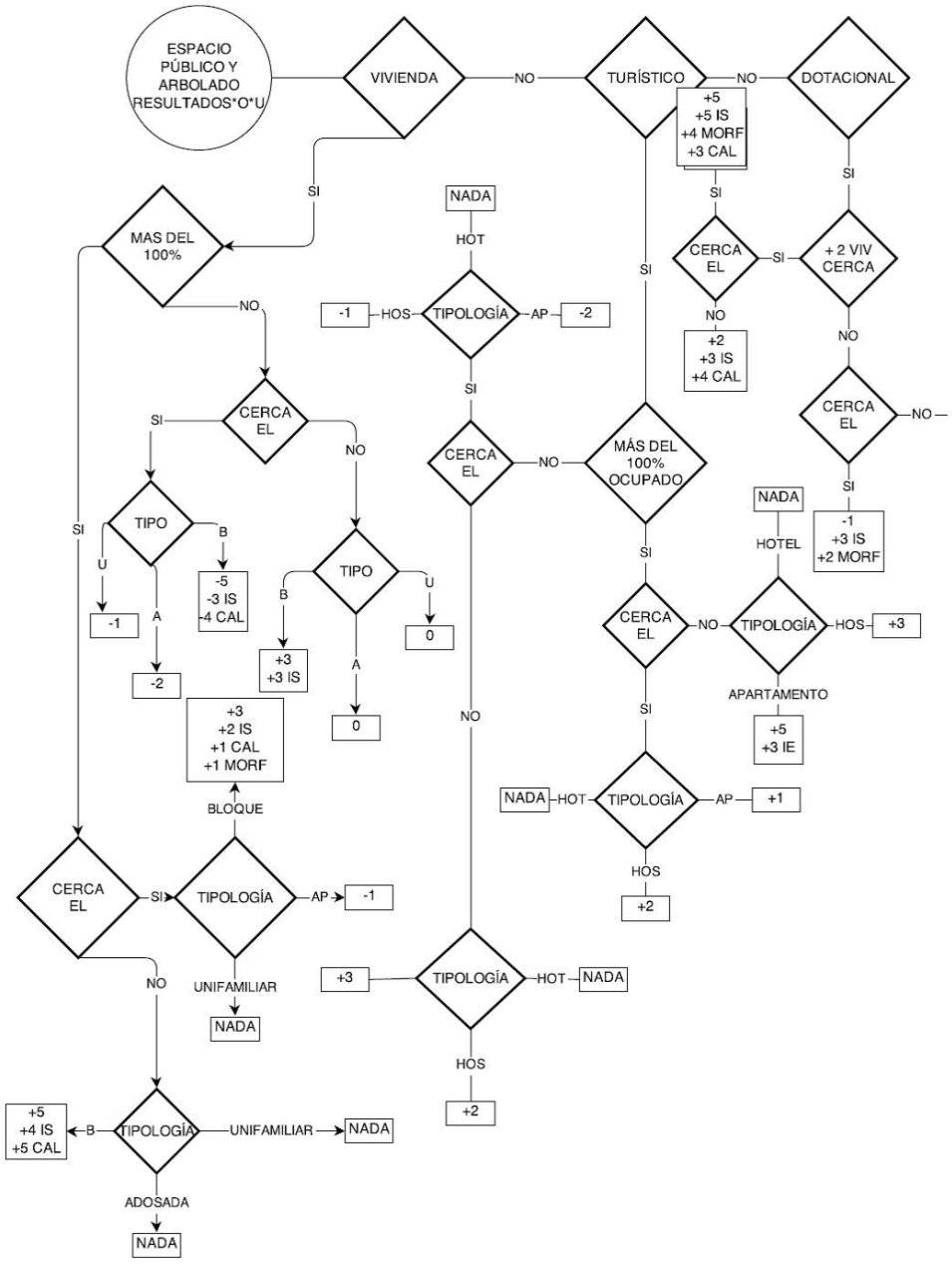


Diagrama de flujos 07. Espacio Público y arbolado. Elaboración propia.

Landscape Impact - 3. Public spaces and vegetation (trees)

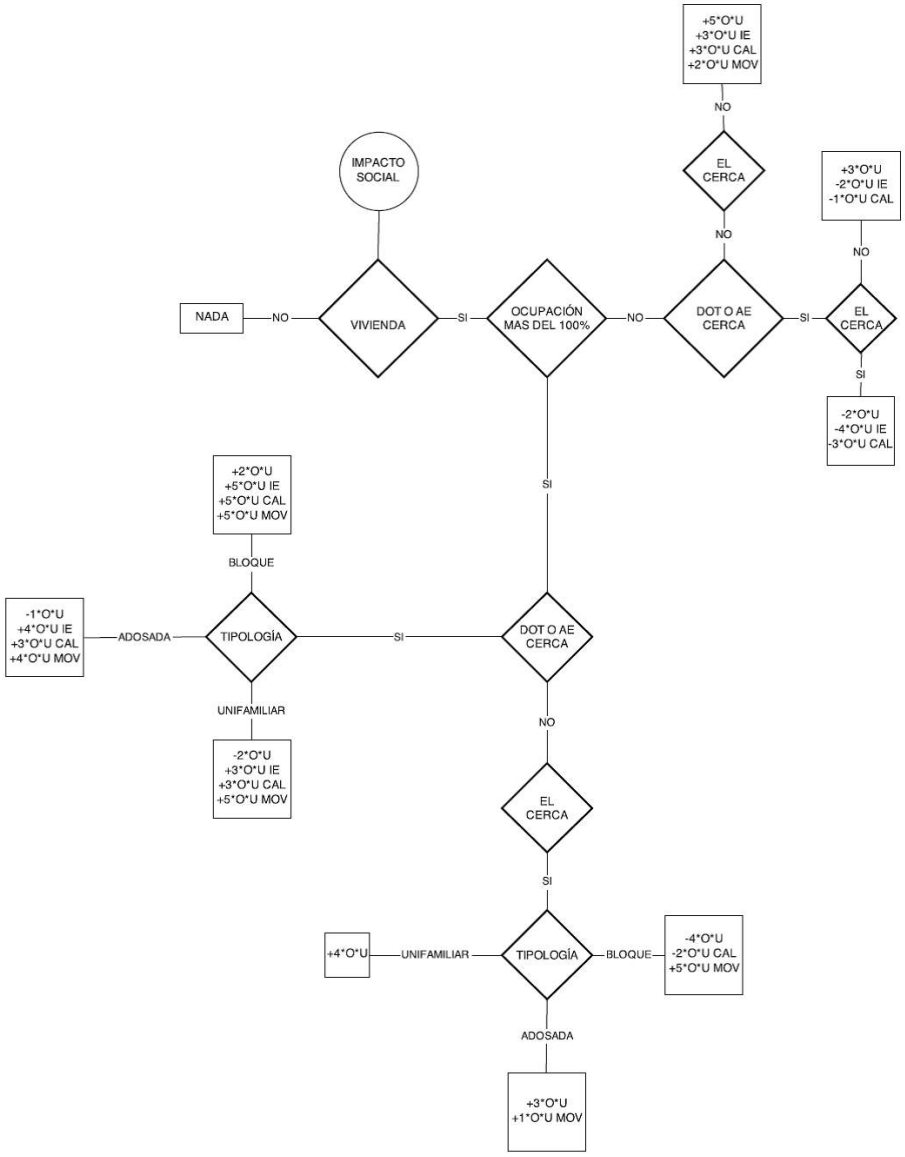


Diagrama de flujos 08. Impacto Social. Elaboración propia.

Social Impact

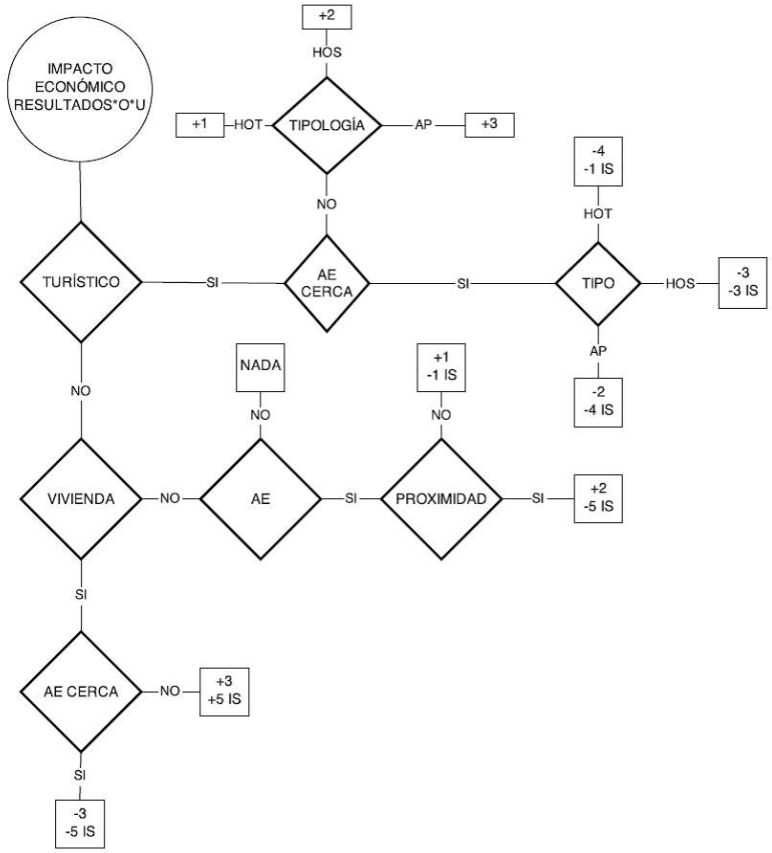


Diagrama de flujos 09. Impacto Económico. Elaboración propia.

Economic Impact

Code: N2_code.nlogo
View it on Github: https://github.com/culturadigital/forma14/blob/master/N2.nlogo

Model snapshots:

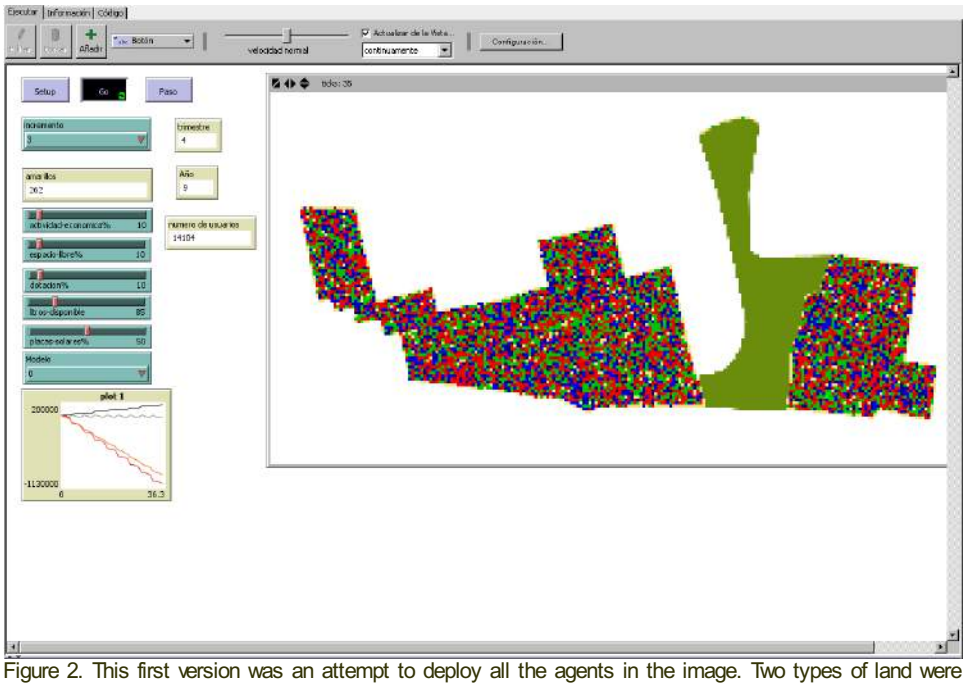


Figure 2. This first version was an attempt to deploy all the agents in the image. Two types of land were created: land hosting any possible use (residential, tourism, services) and open green areas. For the spatial arrangement we used land use percentages and impact increments.

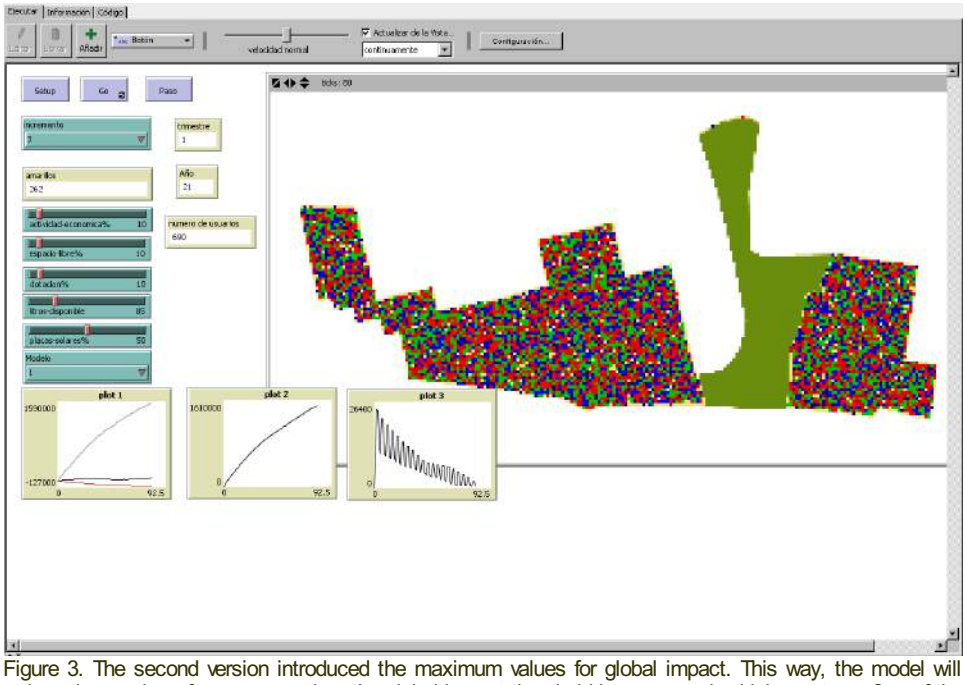


Figure 3. The second version introduced the maximum values for global impact. This way, the model will reduce the number of users every time the global impact threshold is surpassed, which creates a flow of the number of users troughout time.nThe problem with this version is that the model always tops the global impact threshold and therefore the number of users is constantly decreasing. This leads us to identify potential mistakes in the algorithms calculating the individual impact levels.

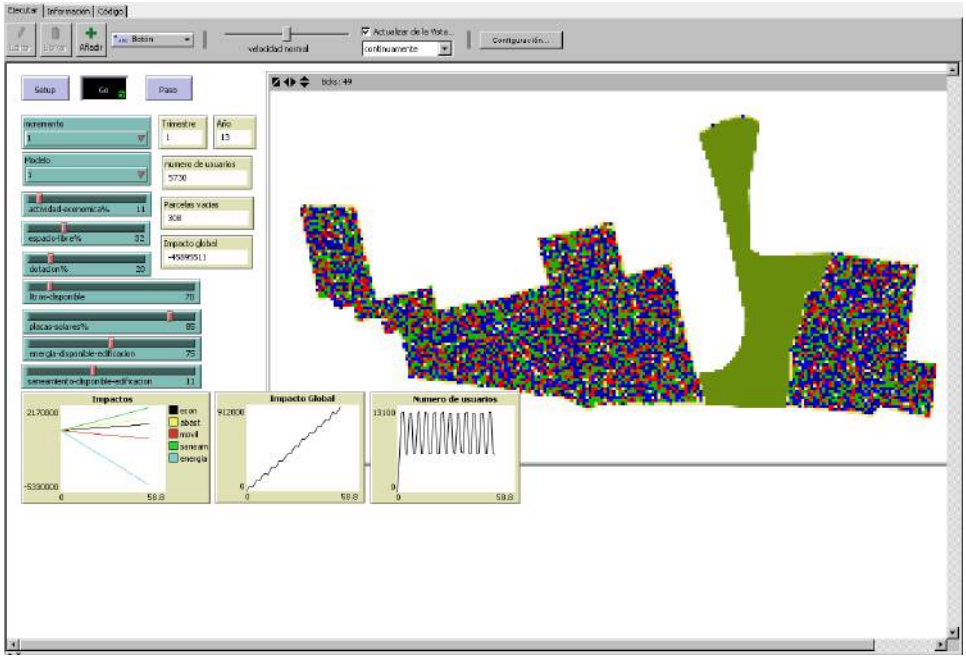


Figure 4. The third version incorporates the variability of the individual impacts in order to adjust them throughout the process. For example, the energy impact may vary according to the initial percentage of solar panels and that poses a strong influence over the evolution of its final values. The same applies to the rest of individual impacts. With this model we finalized the modeling process, from which a general idea of its coding could be obtained as well as the absence of certain aspects that would be necessary in order for it to work as an agent system.

Conclusions: Forma14 has been a continuation of Forma13, but in the first edition we focused on understanding how to apply agent systems to our research problem, then in this edition, we started off from a conceptual model where a formal approach to the idea of hosting capacity was established.

During the process, we realized that although most of the ODD protocol was apt for modelling, we were lacking concepts in the line of adaptation and learning. In our view, the base of the model is correct, but the work of the conceptualization remains constant through time. The model, ambitious in the amount of variables and relationships, needs conceptual simplification and further complexity in the way

behaviours evolve through time.

References:

- Batty, M. "Urban Modeling", International Encyclopedia of Human Geography, vol. 12, pp. 51-58.
- Martínez, F.L. & Morales, Y.O. "Agent-based simulation approach to urban dynamics modeling", DYNA (Colombia), vol. 79, no. 173 PART II, pp. 34.
- G. Lobo. "La Ciudad no es un juguete: cómo SimCity juega con el urbanismo".
- Zhang, H., Wang, X., Yong, Y. & Ho, H.H. "Eco-health evaluation for the Shanghai metropolitan area during the recent industrial transformation (1990-2003)", Journal of environmental management, vol. 88, no. 4, pp. 1047.

Annex:

Agent	State variable	Units	Variable local / global /auxiliary
Vivienda	Número de usuarios	Número (0-50)	Local
	Incremento (PI / SI / TI)	Número (1-2-3)	Global
	Estacional	Si / No_ S/N	Global
	Nivel de ocupación	Porcentaje_%	Local
	Trimestre	Número (1 – 4)	Global
	Disponible agua	Litros_ L	Local
	Disponible saneamiento	Metros cúbicos_ m3	Local
	Disponible energía	Potencia_kw	Local
	Placas solares	Si / No_ S/N	Auxiliar
	Consumo agua	Litros_ L	Local
	Consumo saneamiento	Metros cúbicos_m3	Local
	Consumo energético	Potencia_kw	Local
	Tipología	Bloque/Adosado/Unifamiliar (B/A/U)	Local
	Agrupado	Si / No_ S/N	Auxiliar
	Ciclo del agua	Número	Local
	Saneamiento	Número	Local
	Energía	Número	Local
	Movilidad No motorizada	Número	Local
	Impacto funcional	Sumatorio Número	Local
	Tipología y morfología	Número	Local
	Calidad proyectual y constructiva	Número	Local
	Espacio público y arbolado	Número	Local
	Impacto paisaje urbano	Sumatorio Número	Local
	IMPACTO AMBIENTAL	Sumatorio Número	Local
	IMPACTO SOCIAL	Número	Local
	IMPACTO ECONÓMICO	Número	Local
Turístico	Número de usuarios	Número (0-300)	Local
	Incremento (PI / SI / TI)	Número (1-2-3)	Global
	Estacional	Si / No_ S/N	Global
	Nivel de ocupación	Porcentaje_%	Local
	Trimestre	Número (1 – 4)	Global
	Disponible agua	Litros_ L	Local
	Disponible saneamiento	Metros cúbicos_ m3	Local
	Disponible energía	Potencia_kw	Local
	Placas solares	Si / No_ S/N	Auxiliar
	Consumo agua	Litros_ L	Local
	Consumo saneamiento	Metros cúbicos_m3	Local
	Consumo energético	Potencia_kw	Local
	Tipología	Hotel/Hostal/Apartamento (HOT/HOS/AP)	Local
	Agrupado	Si / No_ S/N	Auxiliar
	Ciclo del agua	Número	Local
	Saneamiento	Número	Local
	Energía	Número	Local
	Movilidad No motorizada	Número	Local
	Impacto funcional	Sumatorio Número	Local
	Tipología y morfología	Número	Local
	Calidad proyectual y constructiva	Número	Local
	Espacio público y arbolado	Número	Local
	Impacto paisaje urbano	Sumatorio Número	Local
	IMPACTO AMBIENTAL	Sumatorio Número	Local
	IMPACTO SOCIAL	Número	Local
	IMPACTO ECONÓMICO	Número	Local

	IMPACTO ECONÓMICO	Número	Local
Actividad económica	Incremento (PI / SI / TI)	Número (1-2-3)	Global
	Proximidad	Sí / No_ S/N	Local
	Estacional	Sí / No_ S/N	Global
	Nivel de ocupación	Porcentaje_%	Local
	Trimestre	Número (1 – 4)	Global
	Disponible agua	Litros_ L	Local
	Disponible saneamiento	Metros cúbicos_ m3	Local
	Disponible energía	Potencia_kw	Local
	Placas solares	Sí / No_ S/N	Auxiliar
	Consumo agua	Litros_ L	Local
	Consumo saneamiento	Metros cúbicos_m3	Local
	Consumo energético	Potencia_kw	Local
	Agrupado	Sí / No_ S/N	Auxiliar
	Ciclo del agua	Número	Local
	Saneamiento	Número	Local
	Energía	Número	Local
	Movilidad No motorizada	Número	Local
	Impacto funcional	Sumatorio Número	Local
	Tipología y morfología	Número	Local
	Calidad proyectual y constructiva	Número	Local
	Espacio público y arbolado	Número	Local
	Impacto paisaje urbano	Sumatorio Número	Local
	IMPACTO AMBIENTAL	Sumatorio Número	Local
	IMPACTO SOCIAL	Número	Local
	IMPACTO ECONÓMICO	Número	Local
Dotación	Incremento (PI / SI / TI)	Número (1-2-3)	Global
	Proximidad	Sí / No_ S/N	Local
	Estacional	Sí / No_ S/N	Global
	Nivel de ocupación	Porcentaje_%	Local
	Trimestre	Número (1 – 4)	Global
	Disponible agua	Litros_ L	Local
	Disponible saneamiento	Metros cúbicos_ m3	Local
	Disponible energía	Potencia_kw	Local
	Placas solares	Sí / No_ S/N	Auxiliar
	Consumo agua	Litros_ L	Local
	Consumo saneamiento	Metros cúbicos_m3	Local
	Consumo energético	Potencia_kw	Local
	Agrupado	Sí / No_ S/N	Auxiliar
	Ciclo del agua	Número	Local
	Saneamiento	Número	Local
	Energía	Número	Local
	Movilidad No motorizada	Número	Local
	Impacto funcional	Sumatorio Número	Local
	Tipología y morfología	Número	Local
	Calidad proyectual y constructiva	Número	Local
	Espacio público y arbolado	Número	Local
	Impacto paisaje urbano	Sumatorio Número	Local
	IMPACTO AMBIENTAL	Sumatorio Número	Local
	IMPACTO SOCIAL	Número	Local
	IMPACTO ECONÓMICO	Número	Local
Espacio libre	Zona comunal	Sí / No_ S/N	Local
	Incremento (PI / SI / TI)	Número (1-2-3)	Global
	Estacional	Sí / No_ S/N	Global

N3. EVOLUTION OF HUMAN COOPERATION AND VIOLENCE: THE ORIGIN OF METAPOPULATIONS AND SOCIO-ECONOMIC NETWORKS WITHIN PREHISTORY

Author:
Daniel García Rivero - Universidad de Sevilla
garciarivero@us.es

Collaborators:
Juan Galán Páez (lead) - Universidad de Sevilla
Rafael Gómez Galbarro
Francisco Perfectti
Pedro Ros Reina
Aline Lara Galicia
Antonio Paredes Moreno

Brief: According to currently available archeological data, the origin of human populations (of hundreds or thousands of individuals) takes plane in the recent Prehistory, more specifically, in the Bronze Age period. These groups of individuals are called chiefdoms in social anthropology: chiefdoms societies are known to own a number of features as certain internal variation, division of labor, foodstuff storage, craftsmen and other segments of society exempt of physical effort (like agriculture or livestock), social hierarchy, etc.

In particular, in the Iberian Peninsula is at the beginning of Copper Age (around year 3000 BC) when starts the emergence of big populations as well as extensive and sound cooperation networks interlinking those. At this point, archeological sites show: large fortified settlements (with walls, towers with loopholes and other poliorcetics related elements); developed weaponry (knifes, arrowheads, spears, etc.); material culture with biased (non-uniform) spatial distributions at both, intra and inter-societal levels, where some objects denote certain social level and therefore can only be found in certain segments of society; asymmetric and hierarchical settlements organization around possibly assembled territories (by means of religion and politics); first collective burials (megalith) and princely graves; etc.

Key question: Under which conditions and historical factors it is possible the emergence of complex and large agriculture and livestock-based societies where collectivity prevails over individuality (around IV-III millenniums BC)?

ODD Protocol:
1. Hypothesis:

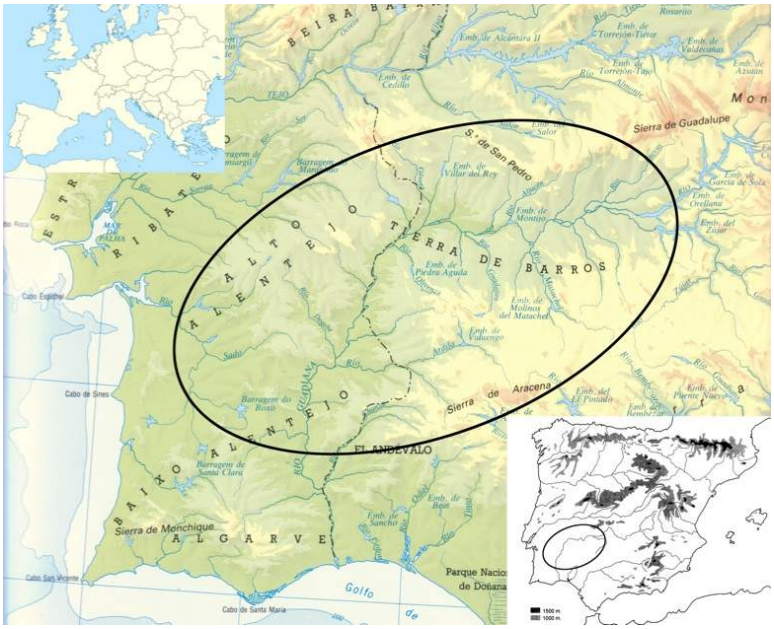


Figure 1. Geographical area of research

Cooperation between individuals or groups tends to be higher in contexts where resource competition is high, implying a higher violence rate. That is to say, situations where group collective interests are threatened. Higher the competition, higher the cooperation, leading to the emergence of larger communities, and larger the communities, greater their capacities to compete for resources (more powerful armies, stronger economies, etc.)

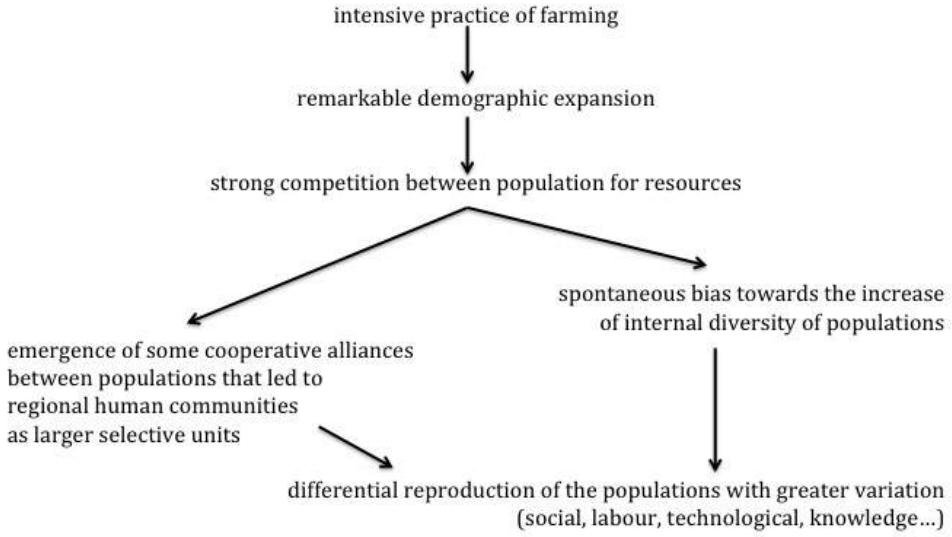


Figure 2. Preliminary ideas before model development

The main theoretical ideas the model must implement are the following:

a) Extensive farming development (including irrigation, animal drawn tools, etc.). Archeological sites show an increase of agricultural tools like teeth-made sickles and thresh; hand grinders, etc.

b) Demographic growth due to: the higher availability of resources from agriculture and livestock; production of dairy products, textile industry, etc. Archeological sites show an increase in the number and size of populations.

c) Strong resource competition due to: heavily populated areas; huge areas devoted to agriculture and livestock (for large populations), need of resources stockade and products interchange between distant populations.

d) Increase of violence and development of poliorcetics.

e) Development of inter-societal bonds at different levels (individuals, segments of society, populations, etc.). These relationships emerge due to a number of hypothesized historical issues and situations, as well as the necessity of creating bigger entities with a higher combat strength. Archeological sites show settlement patterns in big areas and networks of goods interchange along these areas.

f) Increase of internal variation in terms of labor division, leading to more competitive societies. Some segments of society have tasks that are not directly related to foodstuff production. Settlements show different social levels spatially distributed (in some areas valuable objects have been found). Large and heterogeneous ones rapidly replaced small and homogeneous settlements.

g) Beginning of new cultural systems (symbolic systems, religions focused on human deified leaders, etc.) allowing these new societies increasing even more their population and size. Deified leaders increase society integration and cohesion since decrease ideological differences between individuals.

Features to be considered and measured during model execution (to be matched after simulations with real data collected from Archeological sites):

1. Demography, for which variables are:
   - Number of settlements.
   - Size of settlements.
   - Dispersion/pattern of settlements.
2. Warfare technology, for which variables are:

- Presence/absence of defensive ditches and walls surrounding settlements.
- Presence/absence of weapons.

3. Hierarchy and social status, for which variables are:
   - Presence/absence of differentiated spaces within settlements.
   - Presence/absence of social prestige objects.
   - Dispersion/pattern of social prestige objects.

These variables are informative of the degree of internal variation and level of social hierarchy of the populations.

Parameters and behavioral rules to be considered for individuals and groups within the model (model is situated in an environment where resources are limited):

- Individual profit: individuals aim to maximize their profit.
- Cooperation limits: An individual will cooperate with others as long as it is not detrimental for itself.
- Relatives' selection: An individual tends to cooperate with individuals closer (from a genetic and/or cultural point of view) to itself.
- Cooperation rules (cf. Nowak 2006): Relatives' selection, direct/indirect/network reciprocity and group selection.
- Competition/rivalry between individuals and populations (cf. Hutchinson 1981: 275-295):
  1. If the influence an individual from a settlement A has over another individual from a settlement B is higher than the influence it has over an individual from its own settlement (A), and the influence the individual from settlement B has over an individual from settlement A is lower than the influence it has over an individual from its own settlement, then settlement A will take the place of settlement B.
  2. If both individuals have more influence over other settlement than over their own, then the winning settlement will depend on settlements' population.
  3. If both individuals has more influence over their own settlements than over others settlements, then settlements' coexistence is possible.
- Other factors:
  1. Social hierarchy level (existence of a leaders).
  2. Religious hierarchy level (existence of divine leaders).

2. Description of the developed model:

Entities of the model (agents/individuals, units of space, environment, etc.): Each agent represents human settlement.

Model extension (in terms of time and space): The world consists in a 250 X 150 grid corresponding to a 250 (East-West) X 150 (North-South) Km area, and is executed for 2,000 ticks, which is equivalent to a 2,000 years period.

Attributes and/or state variables: Agents (settlements) own the following attributes:

- Diversity level: Internal variation level of society. Values:
  1. Livestock
  2. Agriculture
  3. Livestock and agriculture
  4. Livestock, agriculture and craftwork
  5. Livestock, agriculture, craftwork and leadership
- Technology level:
  1. Plow
  2. Poliorcetics
  3. Metallurgy

The values for these two attributes are:

- a) Diversity: 0 / 1 --> 2 --> 3 --> 4
- b) Technology: 1 --> 2 --> 3

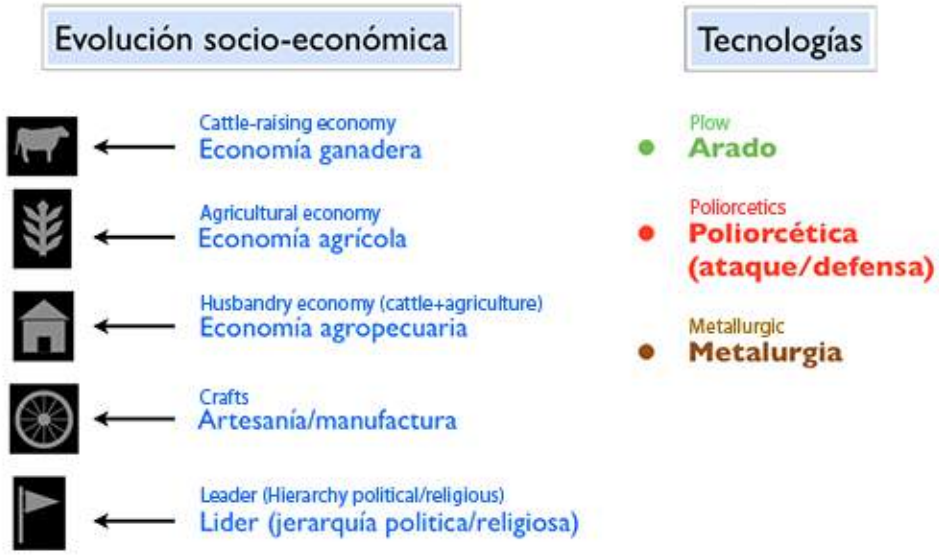


Figure 3 & 4. Socio-economic evolution and technologies

Behavioral rules - Agents (settlements) follow the following basic rules:

- Agents (settlements) aim to maximize their profit (population increase and replication).

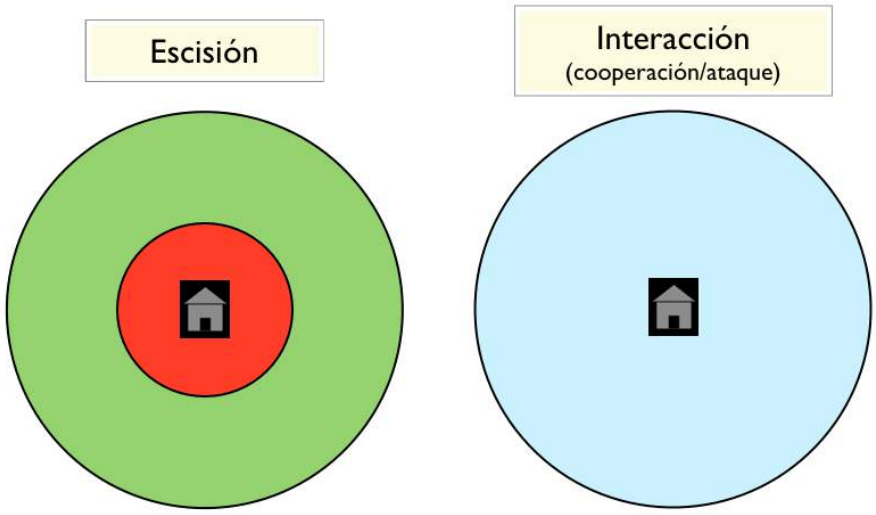


Figure 5. Split and cooperation/attack symbols

Settlements' population limit depends on their Diversity and Technology levels. Initially each settlement has a population limit of 100. The limit will increase till 150 when society achieves the plow (Technology level 1, which also requires Diversity level 2). In this case the population growth rate will increase to 20% (from an initial value of 10%). Societies achieving leadership (Diversity level 4) will see their population limit increased till 500.

- Agents (settlements) interact with each other within a range of 25 patches (25 Km) starting with the closest ones. The result of each interaction could be cooperation or fight:

F(A,A) = Settlement(A) * (1 + 0.165 * M(A)) where M(X) = plow(X) + metallurgy(X) + livestock(X) and agriculture(X) + craftwork(X) + leadership(X) – poliorcetics(X) (all of these take 0 or 1 if settlement A already achieved it or not).

F(A,B) = Settlement(A) * T(A) – Settlement(B) * T(B) where T(X) = (1 + 0.165 * M(X)) and M(X) = plow(X) + metallurgy(X) + livestock(X) and agriculture(X) + craftwork(X) + leadership(X) – poliorcetics(X) (all of these take 0 or 1 if settlement A already achieved it or not).

If the interaction results in a fight, the settlement with greater influence will take the place of the other. If settlement A won the battle, the new population limit for A will be: NewLimit(A) = Limit(A) + Population(B).

If the interaction results in cooperation an interchange of Technology and Diversity between settlements takes place.

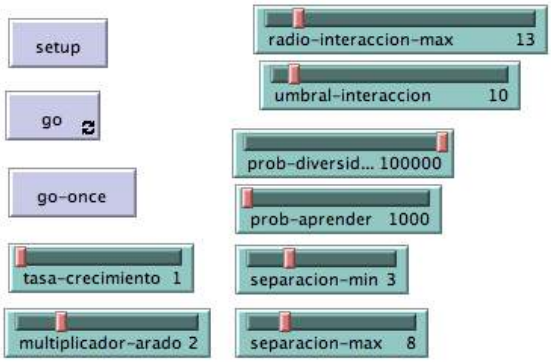


Figure 6. Control panel of the model

Model initial conditions: Initially there are 3 settlements with: random population sizes between [20,30], random Diversity levels between [0,2]. Probability distribution for diversity is [0:15%, 1:15%, 2:70%] i.e. initially most of the populations have agriculture and livestock.

Sequence of events during model execution - The probability of level transitions is given by 1/100,000 for Diversity and 1/1,000 for Technology. Also there are some dependencies between both variables:

1. Achievement of plow requires Diversity level 2
2. Achievement of Metallurgy requires Diversity level 2

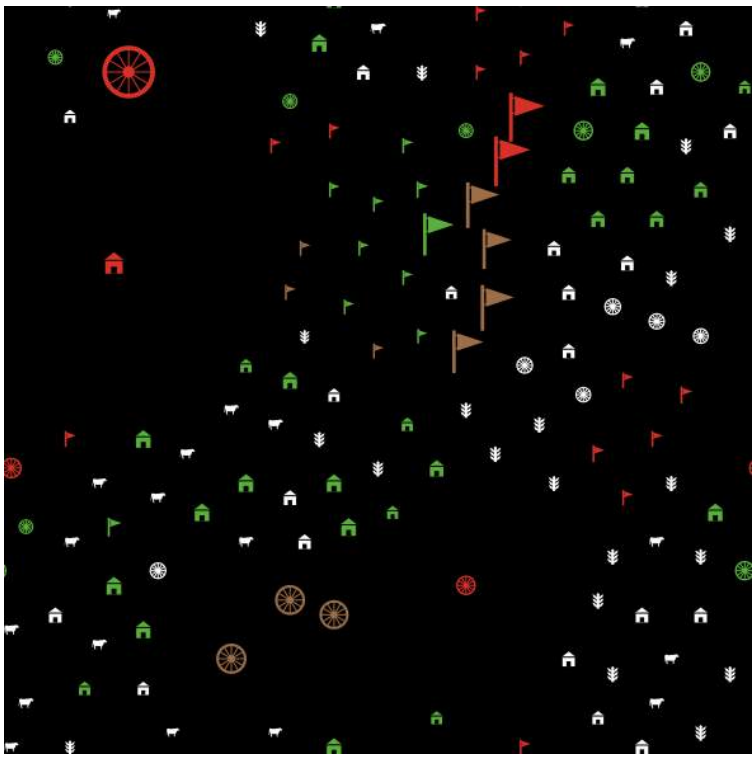
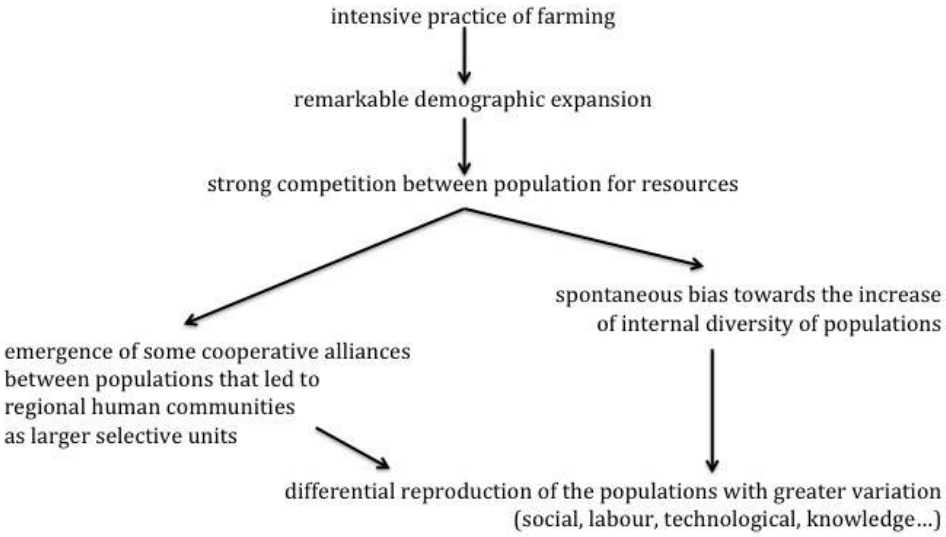


Figure 7. Sequence of events during model execution

Flow chart:



Code: N3_code.nlogo
View it on Github: https://github.com/culturadigital/forma14/blob/master/N3.nlogo

Model snapshots:

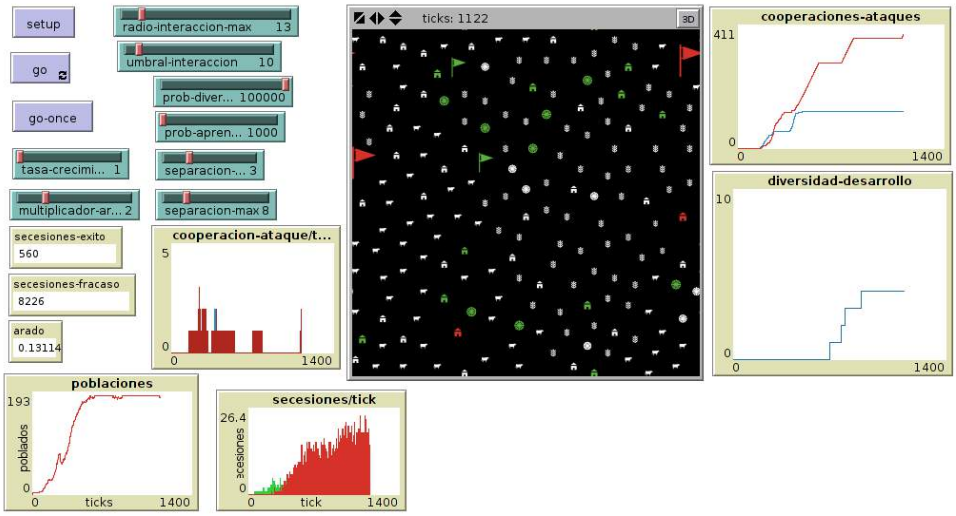


Figure 8. System at runtime

Results and conclusions:

- Demographic explosion

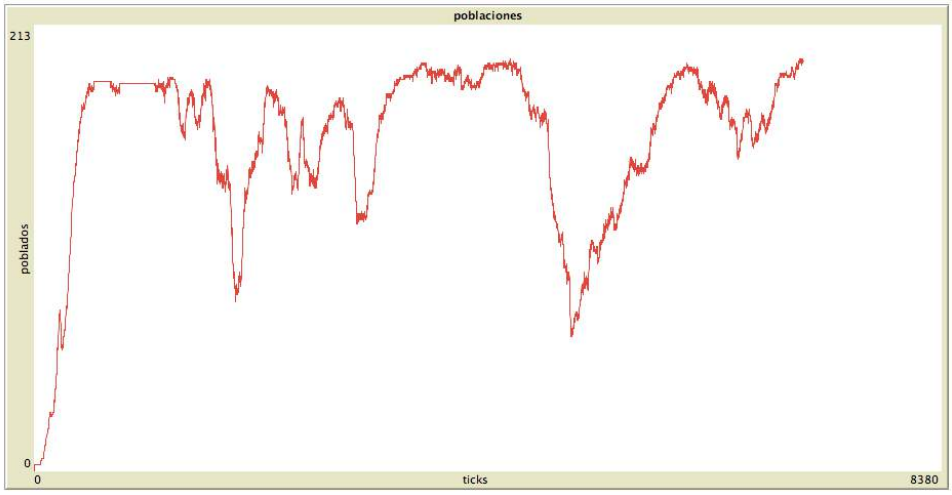


Figure 9.

- Competition is correlated (must be formally verified) with an increase of settlements internal diversity.

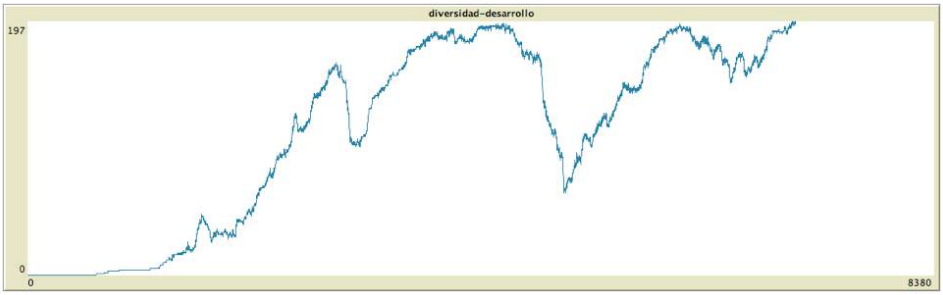


Figure 10.

- Simulation shows an increase in the number of settlements with high social complexity (Diversity level) whilst in some simulation stages settlements with low social complexity almost disappear.
- Cooperation and competition levels initially have the same growth rate. After the demographic growth is stabilized, cooperation level becomes higher than competition level.

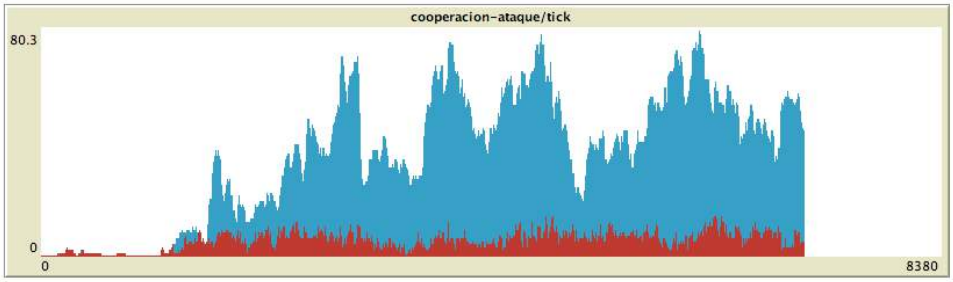


Figure 11.

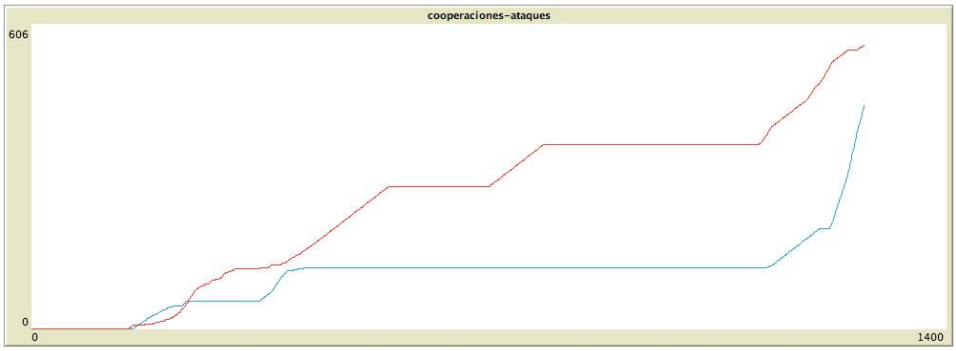


Figure 12.

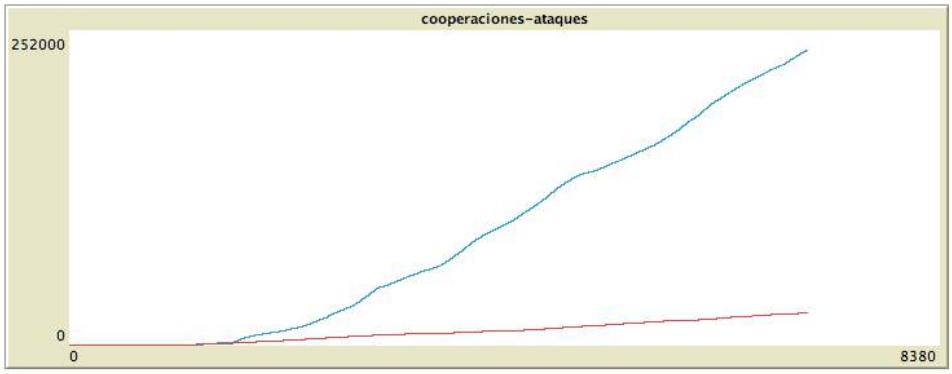


Figure 13.

References:

- Axelrod, R. (1997): The complexity of cooperation: agent-based models of competition and collaboration. Princeton: Princeton University Press.
- Axelrod, R.; Hamilton, W.D. (1981): The evolution of cooperation, Science 211 (4489): 1390-1396.
- Carneiro, R.L. (1970): A theory of the origin of the state, Science 169 (3947): 733-738.
- Johnson, A.W.; Earle, T. (2003): La evolución de las sociedades humanas: desde los grupos cazadores-recolectores al estado agrario. Barcelona: Ariel.
- Sigmund, K.; Fehr, E.; Nowak, M.A. (2002): The economics of fair play, Scientific American 286 (1): 82-87.
- Hammerstein, P. (2003) (Ed): Genetic and cultural evolution of cooperation. Cambrigde, MA y London: MIT Press.

N4. PEDESTRIANIZATION OF THE HISTORICAL CENTRE OF QUITO. A WAY TO THE CONSERVATION OF THE CULTURAL HERITAGE.

Authors:
Elizabeth Regalado Bolaños - Universidad Central de Ecuador
Iván Medina Carranco - Universidad Central de Ecuador
Zoila Ruiz Chávez - Universidad Central de Ecuador

Collaborators:
David Solís Martín (lead) - Universidad de Sevilla
Francisco Manuel Sanchez Castillo
Juan Luis Sánchez Fuentes
Andrés José Prieto Ibáñez
Jose Miguel Hernandez Segura
Juan Francisco Ojeda Jiménez
Alejandro Romero Reche
Mónica Rueda García

Brief: Ecuador is currently promoting tourism as an important income source, giving a greater role to the city of Quito, which was the first city in the world to be given the status of World Heritage by UNESCO. Quito is one of the most touristic cities in Ecuador, a tradition that draws mainly from its historic quarter, containing around 130 monumental buildings with a great variety of art styles in sculptures and paintings of religious nature in its majority. It also contains more than 5000 buildings registered under the heritage inventory of the National Institute of Cultural Heritage (INPC).

The digital documentation system of the INPC (ABACO) holds the conservation state of all the (material) cultural entities of the cultural heritage of Ecuador, which shows the level of conservation risk currently affecting monuments, buildings, public squares etc. due to the high vehicular traffic in Quito's historic quarter. For this reason, there is an initiative to pedestrianize the aforementioned quarter as a means to protect and conserve the heritage in this area.

For the authorities of the city of Quito, this initiative has become an unfulfilled target. The proposal has been considered several times but however, it has not been possible to implement so far. Being this pedestrianization a fundamental strategy for the conservation of the cultural heritage, the present study attempts cast light on the evaluation of the different proposals for such intervention. This is, an attempt to develop a tool that will allow to test different scenarios, visualizing, identifying and fixing problemswithout having to implement them for real. The model will become an aiding tool for managers, experts and authorities in the process of decision making.

The aim is to model the pedestrianization of the historic quarter of Quito, taking into account the current physical distribution of all the monuments that make up the cultural heritage of this area. For this purpose, there is data available regarding streets, buildings and squares in GIS format (from the SNI), and all the monument conservation data from ABACO, plus all the data regarding public transport from the municipality of Quito.

Key question: What is the best way to carry out a pedestrianization of the historic quarter of the city of Quito?

ODD Protocol:
1. Overview

Purpose: We want to simulate the traffic in the historical centre of the Quito city using multi-agent systems. This will allow us to try out differents choices the pedestrianization streets and see the effect of this modifications in the traffic flow of the historical centre of the Quito.

Currently, due to Quito is enclosed between mountains, all traffic car go through to historical centre. That strong traffic flow are the principal element of the damage in very antique buildings that compose the cultural heritage of the city. We thought that a tool to simulate different options of the pedestrianization could be very helpful to find a

equilibrium between the city movility and the conservation.

On the other hand, to find that balance, no only will help to preserve cultural rich buildings, in addition it will promote a better tourist circulation.

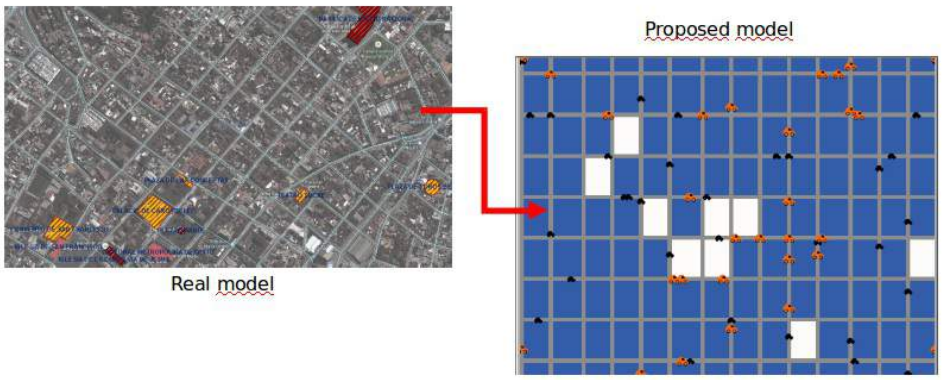


Figure 1. Model abstraction

2. Entities, state variable and scale

In the model we found three entities: streets, vehicles and buildings:

- The streets have a direction (test: L,R,D,U) and identify if it is a interception (booelan) or/and if it is peatonal (booelan).
- The vehicles could be of differents sizes (text: public or private), a polution radius (decimal) and a direction of circulation (text: NS or SN).
- Each building have a conservation state (decimal)

The sets of rules regarding spatial cells include:

- The entrance of fresh medium.
- The culture stirring or agitation to avoid adhesion of bacteria in the input flow mechanism or in order to achieve homogenization.
- Output of medium (with nutrient and product) and bacteria.

The model have been focused in the zone centre of Quito in the present years and during a day.

3. Process summary and planification

The vehicles which represent to public transport have a defined route and the particular cars move freely. The 90% of the vehicules going through the centre and affect to the cultural buildings in function of theirs own population radius.

The facades of the cultural buildings are affected progressively with the pass of the vehicles.

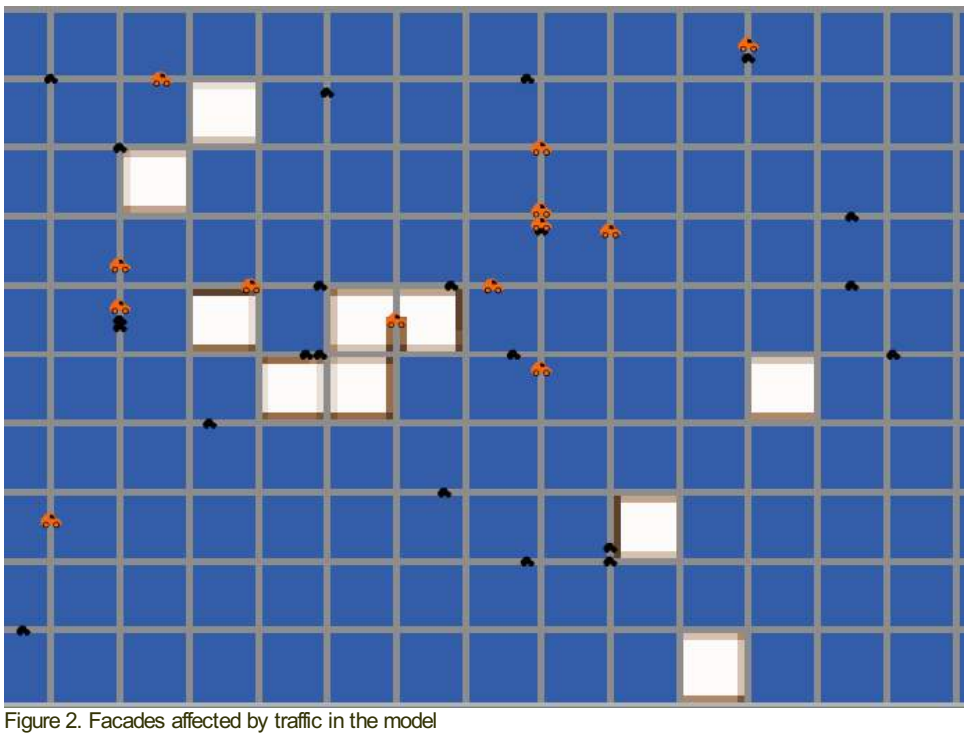


Figure 2. Facades affected by traffic in the model

The different processes are executed on the follow order:

- 1. Generation of the buildings and streets with a random direction.
- 2. The generated medium is validated. If it is not valid the previous step is executed.
- 3. The user can define the pedestrian streets.
- 4. The vehicles are generated with a size and direction.
- 5. During the execution of the model the total polution and the building's affectation are measured.
- 6. The polution is showed in a graph.

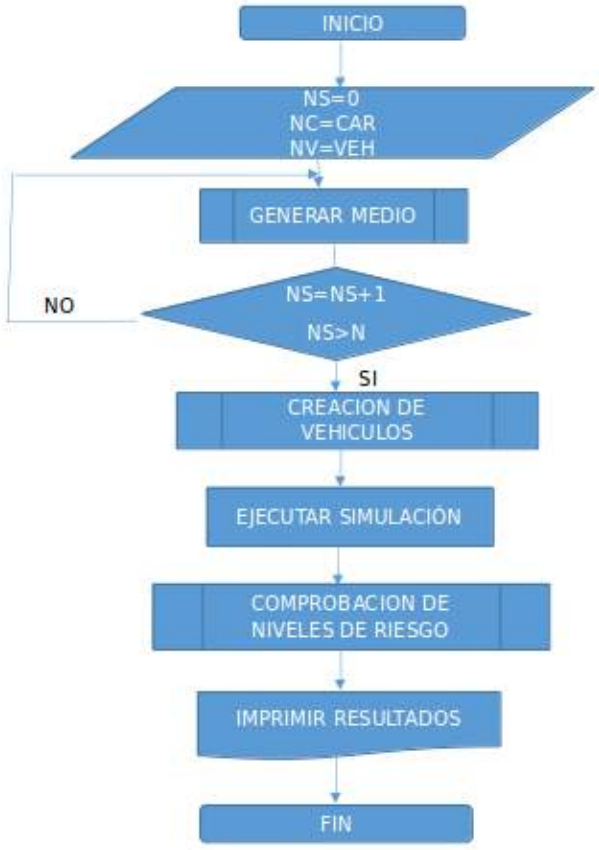
All entities are executed in the same time to allow see the interatation each other and determinate how affect each of them in the historical centre.

4. Design concepts

- Basic principales: Is considerated that the traffic that go through to the Quito centre causes a long-term structural damage over the buildings and and monuments located near of those streets. Is considered the hypothesis that a partial reduction of the traffic could minimize the impact of this phenomenon.
- Emergence: The decision of take a new way to allow to a vehicle to arrive to the target, the change of the traffic flow because of to close a street and the posibility to create new streets to connect the south with the north of the Quito centre in the rush hours are modeled like emerging results. On the other hand, the directions of the streets and the patrimonial locations not depend of the individuals behaviour.
- Adaptation: The vehicules must to find a new way to arrive to theirs destinations keeping in mind the direction streets and the existing connectivity between differents streets.

The main objetive of the vehicles is arrive to the destination in the lower possible time, so the movement of the vehicles is modeled following a direction N-S or S-N with a low percent of times taken a direction W-O or O-W. That behaviour sure that a vehicle will arrive to the south or to the north crossing the centre.

Flow chart:



Code: N4_code.nlogo
View it on Github: https://github.com/culturadigital/forma14/blob/master/N4.nlogo

Model snapshots:

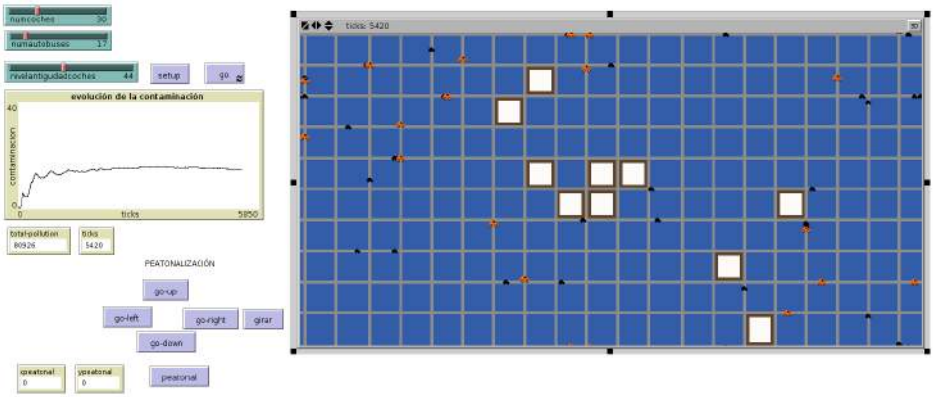


Figure 3. System status at simulation startup

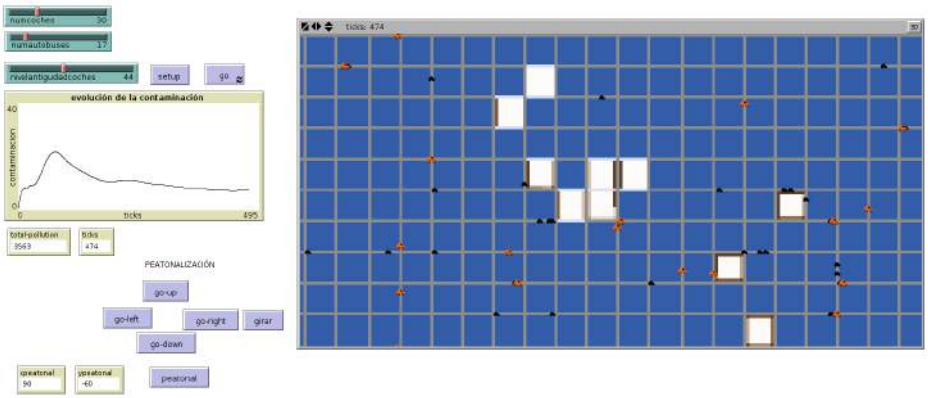


Figure 4. System status at runtime

References:

- Gordón, M. (2012) "Movilidad Sustentable en Quito: una visión desde los más vulnerables", (Flacso-AVYA YALA).
- Carrión, F. "Peatonización del Centro Histórico", FLACSO, Facultad Latinoamericana de Ciencias Sociales. Sede Ecuador.
- Gutiérrez, J. "Transporte, Movilidad y Turismo en los Centros Históricos", Ería 47 (1998), pags 241-248.
- http://www.andes.info.ec/es/noticias/meta-ecuador-es-hacer-turismo-primera-fuente-ingresos-no-petroleros-dice-ministra.html
- http://repositorio.ute.edu.ec/bitstream/123456789/8379/38/18024_43.pdf

N5. METROPOLITAN EXPANSION AND MOBILITY IN ANDALUCIA

Authors:
Gwendoline de Oliveira Neves - Universidad Pablo de Olavide
gsaroli@upo.es
Claudia Hurtado Rodríguez - Universidad Pablo de Olavide
Jesús Santiago Ramos - Universidad Pablo de Olavide

Collaborators:
Yago Fernández Rodríguez (co-lead)
Teodoro González Manchón (co-lead)
José Núñez Porras
Francisco José García Gómez
Carlos Falgueras García

Brief: Since the second half of the twentieth century a deep change is being consummated in the urban planning´s history due mainly to private transport development. This change can be seen especially in the design of urban profile that associated to a slight increase in urban population, a large increase in the urbanized area. This mutation is characterized by an accentuation of land consumption and a deep reorganization of spaces towards greater territorial specialization setting new mono-functional centrality linked to leisure, commercial and tertiary spaces and supported in the development of networks which facilitate the flows. From this perspective, the issue of the metropolitan dimension of urban development from the formal understanding of spatial organization poses a fundamental question: metropolitan areas by definition have no end because of the developmental model on which they are based?

In a first stage, the question of the metropolitan´s definition in a territorial dimension as a particular way to organize the land use involves in one hand, consideration of the density and organization of urbanized space, and on the other hand the integration of road network as a cohesive element being considering as optimal a model that tends towards the sustainability of the whole.

Based upon a reflection on the need for a greater consideration of territorial variability of the phenomena in constructing models, it is intended to use the proposed methods and analytic tools within the framework of this experience to tackle this reflection from a diachronic and quantitative approach of an Andalusian metropolitan area illustrative of the degree of conversion of Spanish urban model from the 1990s and the first decade of the XXI century, proposing an approach to the dynamics spaces classified as mono-centric metropolitan (Sevilla), polycentric (Cadiz-Jerez de la Frontera) or linear (Malaga-Costa del Sol). In this way it is intended make available to managers, technicians and metropolitan citizens a global scale tool, allowing not only to place thematically each metropolitan area in their context but also to provide a support instrument to the decision making at the time of carrying out historical follow and a simulation scenario for the development of interventions.

Key question: Is there a limit to the urban expansion of metropolitan areas?

ODD Protocol:
1. Overview

Purpose: The purpose of the model is to simulate metropolitan urban growth in order to gain a better understanding of Andalucia's metropolitan morphogenetic processes. The model will be used to evaluate current theories of urban growth at a metropolitan scale.

Entities, state variables, and scales - Agents in the model are:

- (0) Natural and potentially developable rural land.
- (3) Urban dense and continuous land
- (2) Urban sprawl and continuous land
- (1) Urban sprawl and scattered land

(0) Natural and potentially developable rural land.

(3) Urban dense and continuous land: These are spaces with a dense structure, mainly built areas with a strong component of residential land use but including others like commercial, industrial, leisure, retail, services, etc., which are not significant enough in their size or amount to be considered individually as a separate category. Private gardened areas and other open spaces are sparse. There are no morphological features taken into account (historic quarters, extensions etc.)

(2) Urban sprawl and continuous land: Unbuilt spaces are gardened areas or open spaces without agricultural activity. It is common to find swimming pools and regular-planned trails for the purpose of connecting the plots, which are often hosting a single residential building. They are usually at a certain distance from urban centres and connected to these through a single road.

(1) Urban sprawl and scattered land: In this case, open spaces are mostly either of agricultural use of any kind or ranching, cattle raising etc. Buildings may include farming/ranching infrastructure but there is still a substantial proportion of residential housing. They are typically located next to second tier urban settlements or occupying river meadows. There might be some wild greens scattered among the urbanized areas.

These attributes are measured in hectares, and the dimensions of the model are 1000 columns and 948 rows of 100x100 cells, corresponding to the metropolitan area of Seville from 1956 to 1984. 1 patch in the model corresponds to 1 Ha, and 1 tick to 1 year.

Process overview and scheduling:

- (0) Natural and potentially developable rural land: May change to any other state: 1, 2, 3
- (3) Urban dense and continuous land - Does not change
- 2. Urban sprawl and continuous land - May change to 1 or 0
- 1. Urban sprawl and scattered land - May change to 2 or 0

The order in which each process is executed goes as follows:

1. Calculate the maximum number of patches which can potentially grow during 1 year, per use (z)
2. Identify the adjacent cells for each layer
3. Set attributes to adjacent patches for each layer according to constraints (contact with water bodies, slopes etc.) and conditions (land use and roads)
4. Pick those patches showing higher values for each layer

Each process is divided in three layers according to its urban density (3, 2, 1) and they are executed from higher to lower density (3, 2, 1)

The sets of rules governing the behaviour of each bacterium are:

- Uptake of nutrient particles in order to increase the bacterial biomass, with excretion of the end product to the spatial cell.
- Reproduction by bipartition with the generation of two "new" bacterial cells when the mass is greater than a threshold.
- Viability that is assumed till the mass is under certain threshold, translating the cell to a latency state.
- (i) Active motion only when the bacterium has not achieved nutrient (randomly to a neighbour patch)

The sets of rules regarding spatial cells include:

- The entrance of fresh medium.
- The culture stirring or agitation to avoid adhesion of bacteria in the input flow

mechanism or in order to achieve homogenization.

- Output of medium (with nutrient and product) and bacteria.

The global scheduling of the simulation model is made up of various elements:

- (1) initialization of the system with the input data chosen by the user, where initial configuration of the bacterial population and the spatial environment are set up, as well as the parameters for the operating protocol;
- (2) the main loop (time step), in which all the rules for each bacterium and the medium are implemented and repeated, and the external actions on the system are applied, until reaching the end of the simulation;
- (3) the output of results at the end of each time step.

2. Design concepts

Basic principles, strategies and hypothesis: The underlying concepts and theories of the model are urban growth and the morphogenesis of metropolitan processes in relation to the development of urban mobility. In particular, the hypothesis being explored in this study is that the transportation network is an element that articulates urban growth.

The modelling strategy has been to create a transportation network from which, based on a set of constraints and conditions, the process of growth is organized. In absence of constraints and under favourable conditions, then the denser the network gets, the denser compact the urban fabric.

In addition, there are micro-hypotheses which define the behaviour of the constraints and conditions, and also sub-models such as the one involved in the deployment of shopping malls.

The model will offer a contrast with the real scenario as it works within a time frame from which data is readily available (1956-1984). The comparison and results will be used to evaluate well known theories of urban growth in the context of Andalucia, bringing in some innovative elements as well.

Emergence: The behaviour of the agents will determine the expansion of the urban fabrics of types (1) and (2). However, there is no emergent behaviour expected as it is controlled beforehand. Gradients and masks are less dependent on the interaction between agents.

Adaptation - Land use layers can expand and merge with other layers. Then, agents make decisions according to their interaction and context as follows:

- (0) Natural and potentially developable rural land - May change to any other state: 1, 2, 3
- (3) Urban dense and continuous land - Does not change. Stops when in contact with the mask and may trigger a change in agents type (2) into agents type (1)
- (2) Urban sprawl and continuous land - May change to agent type (1) – densification, and may trigger a change in agents type (0) or (3) into agents type (2) – growth.
- (1) Urban sprawl and scattered land - May change to agent type (2) – densification, or spill over agents type (0) – growth.

Agents do not keep an individual record of success to evaluate their performance, but instead it is assumed that growing until they reach the yearly average (%) of their type is a successful behaviour. Therefore, the objective of the agents is to grow and expand, which can be measured by calculating the area gained for every tick-year and comparing it with the real one in its spatial and statistical organization.

Interaction: The most relevant interactions between agents are the processes of sprawling and compacting of the urban fabric. There is also a direct interaction between different land uses as well as between land types and the external conditions such as topography, water bodies, transportation network and the mask (non-

developable land). Patches at border conditions can be very attractive drawing competition from agents of types (1), (2) and (3)

Collectives: Agents form groups that are affected by and may affect them. These groups are an emergent property of the agent's behaviour. However, group's characteristics and their attributes are designed by the modeller beforehand.

Observation: The main data observed are growth in terms of area per each land type and the visualization of the process. Data is collected at the end of the process and all the data is used as opposed to what usually happens in empirical experiments.

3. Details

Initialization: The initial state of the model is the real situation (cartography and values) as in 1956. There are three initial types of agents that remain until the end of the runtime.

Input data: Real world maps.

Submodels: It is already a submodel of a more complex model.

Simulation and experimentation: The model shall be considered valid as far as it comes close to reality in its quantitative and spatial dimensions. After tweaking the coefficients affecting the different parameters at play, it was possible to achieve a more or less realistic result which was short of accuracy in a 30% due to some problems with the input data.

Flow chart:

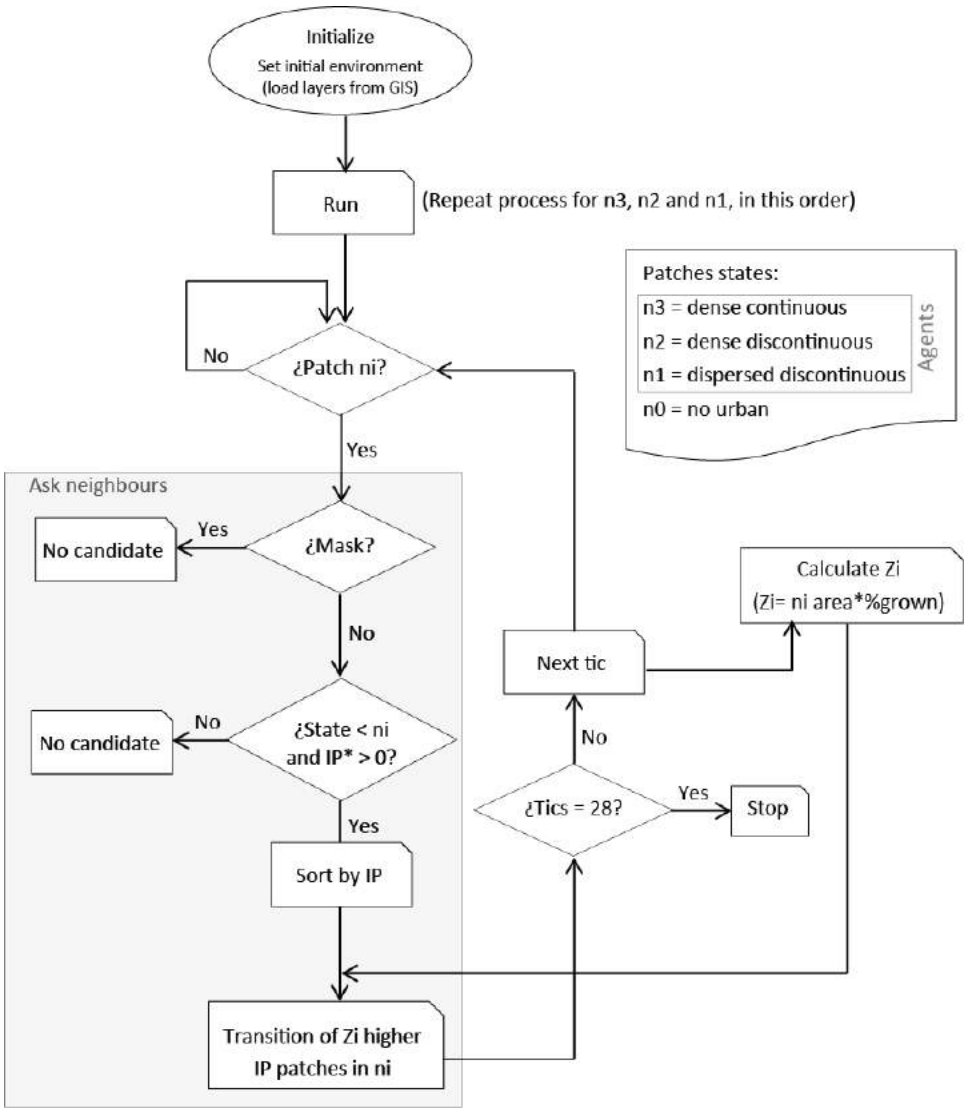


Diagram 01

IP for use i (*)= (GP+(PC*GC)+(PU*GU))/5
GP = Slope gradient
PC = Wheighting of distances to road network (adjustable with sliders)
GC = Gradient of distances to road network
PU = Weighting of distances to urban centres (adjustable with sliders)
GU = Gradient of distances to urban centres
Zi = Number of patches that could potentially change to state “ni” at each iteration, which will be then recalculated after each tick. In any case, those with a higher IP value will change state. When all these patches will have changed state (for n3, n2 and n1), if the number of ticks equals 28 the simulation will end, otherwise the process starts over again.

Code: N5_code.nlogo
View it on Github: https://github.com/culturadigital/forma14/blob/master/N5.nlogo

Model snapshots:

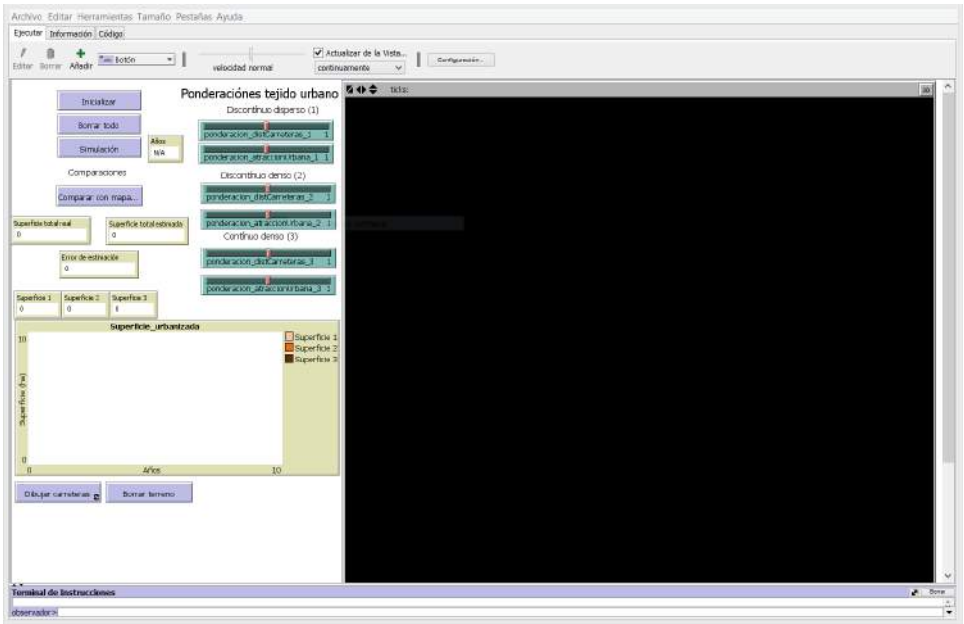


Figure 1. This image shows the initial state of the model before loading geographic information layers from the complete set of maps. At this moment we set the value for the maximum speed, we choose continuous mode and hit start. All layers under the project's directory will be loaded.

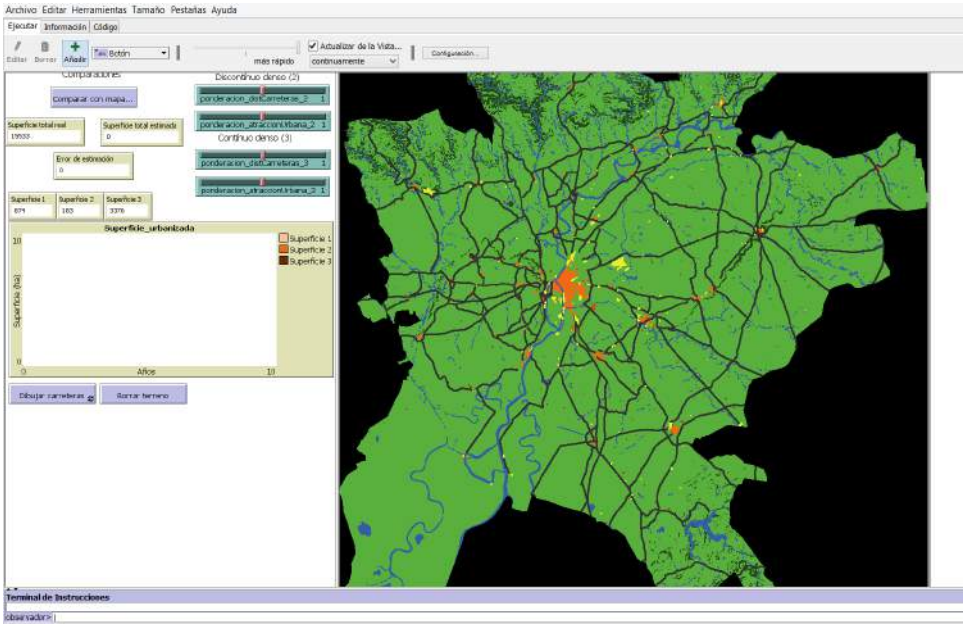


Figure 2. In this image we observe the complete model in its initial state, including all the gegraphic layers: water, contours, roads, urban fabric (dense-continuous land, dense-scattered land, sprawl-scattered), distance between roads, and any other layer that may be needed in the model. At this point we need to change the display seting to "ticks" in order to visualize the resuls properly, and ponderation factors need to be set according to those parameters affecting urban expansion that we want to observe more closely during the simulation. Finally we can proceed to run the simulation to see the evolution.

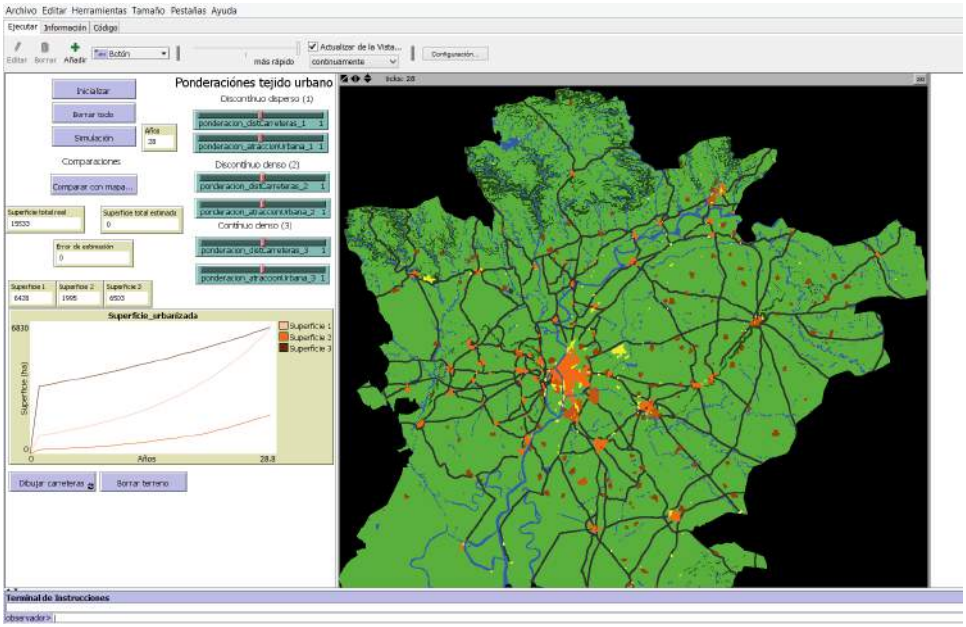


Figure 3. In this image we observe the simulation finalized after 28 ticks (28 years). We may now compare the results with a real map to check how accurate is our model. In this case there is an error of 6,41% It also shows how population density has increased within each of the designated land types (dense-continuous, dense-scattered and sprawl-scattered). During the execution of the process we can track the variations of these values in a graph. At this point we may run another simulation for the following 28 years or start over again with a different setting of the ponderation factors.

Conclusions: Our participation in the FORMA'14 workshop has proven to be a very interesting experience, especially as a first approach to the possibilities of modeling in the field of the analysis of metropolitan spatial dynamics. In relation to the developed model, the first tests show the potential of this tool, although a certain distance in relation to the expected results are observed both in the quantification of urban growth and with regard to its spatial configuration. Some aspects that should be addressed in the future are: (a) the improvement of the input image layers, in order to correct the shortcomings detected in relation to the road network and the urban attraction layers; (b) the weighting of the parameters, in order to adjust more accurately the effect of the different factors considered on the results; and (c) the resolution of some technical problems in relation to the input information. From the perspective of the conceptual design of the model and its future development, it seems clear the convenience of incorporating urban and regional planning as a key factor in urban growth processes. In conclusion, the experience has been satisfactory and is a promising starting point that invites to further explore the potential of this tool.

References:

- Sudhira, H. S., Ramachandra, T. V., Jagadish, K. S., (2004) : "Urban sprawl: metrics, dynamics and modelling using GIS". International Journal of Applied Earth Observation and Geoinformation, 5(1), pp. 29-39

N6. ELECTORATE BEHAVIOR DURING 2004 SPAIN ELECTIONS

Author:
José Luis Sáez Lozano - Universidad de Granada
josaez@ugr.es

Collaborators:
Jesús Horno Cobo (lead)
Alejandro Labrador Ledesma
Ángel Luis Hans Siria
Jessica González Saenz
Antonio Paredes Moreno
Jorge Calvo Martín
Xavier Seguí Salom

Brief: General elections of march the 14th of 2004 (14-M) will be remembered as the elections preceded by the march the 11th attack (11-M). The pre-election surveys before 11-M gave triumph to PP (Partido Popular). After the attack, as time went by, the behaviour of a big amount of voters changed in such a way that the ultimate winner was PSOE (Partido Socialista Obrero Español).

The electoral law in Spain does not allow to publish electoral surveys results within the six previous days before de voting. For that reason, we don't have any study that allow us to identify the psicological factors that lead to that change. We don't have a group of fixed people who were asked before and after the polls either. Definitely, we don't have any cualitative studies that give us information about the reasons for the change of mind in the individual vote.

From my little knowledge of the multiagent modeling, I think that the reasons that made the change in vote orientation could be modeled from factors related to individual behaviour. We have the pre-election survey from the CIS (Centro de Investigaciones Sociológicas), that give us information about the variables that explain the electoral behaviour. From that data, we can simulate how the attack affects the voters. We may select those electors who said that will vote PP and try to make a model to know why a big amount of them decided to refuse or change their votes.

Which factors affect the PP electors to made them change their mind?

The decision of an elector is based on many factors depending of the theory we use to describe the model.

Key question: Which factors affected PP electors, and why did they change their mind after the 11-M attacks?

ODD Protocol:
1. Overview

Purpose: To model the decision of the voters in an individual level at the general poll in Spain in 2004.

The main goal is to explain the behaviour of the voters in a poll preceded by the terrorist attack of the march the 11th of 2004 (11M) three days before the poll.

The ultimate goal is to publish a paper with the data obtained from the model contrasted with the surveys.

Entities, state variables, and scales: We have voters as individual agents and the event 11M and the news and official information after it as enviroment agents.

The agents perceive two state variables: the location that the agent give itself at the ideology spectre and the location each one give to each party.

The attack of the 11th and the news and information published by media and official source strength are considered then enviroment variables.

Variables have no units. Both locations are discrete variable representing the parties

that can be chosen and the relative position of the voter through them.

We have represent the strenght of the news and information as a parameter depending on the distance in the model to the source of information.

In the model the world is a torus. The time dimension are the three days from 11M to 14M. The space in the model try to capture de exposure of the voters to de media information. In the model, each tick represents one hour of time in the three days.

Process overview and scheduling: The agents move in the world changing their minds as they are more or less exposed to media.

At each tick, the agents move one step and then re-evaluate their vote intention. The agent action is made in paralell by all the voters. Time is modeled by discrete ticks representig one hour each.

2. Design concepts

Basic principles: The partisan theory, that predicts that ideological and partisan identification guides the vote. The rational-economical theory, that says that the voter is guided by his own rational evaluation of the situation. The psicopolotical theory, that says that the behaviour of the voters is determined by their own personality and psicosocial factors.

Emergence: The global change in the result of the poll is fostered by the interaction of the agents. Almost everithing is in the general rules except the media exposure of the individuals is determined by the behavior assigned to the individuals.

Adaptation: Individuals change their vote intention more if they are more exposed to media information. Changes in variables affect the vote intention of the agents as opposed to an incremental type of variation.

Objectives: Agents do not aim any particular objective in the model.

Learning: No learning features are implemented in the agents.

Prediction: No prediction.

Sensing: The agents perceive two state variables: the location that the agent give itself at the ideology spectre and the location each one give to each party. They are also affected by the distance to the media source of information as a metaphor of the media exposure of the voters. The agent media don't perceive anything.

The vote intention is the argument of minimize the ideological distance from the auto-location at the ideology spectre and the position asigned by them to all of the parties. At the end, the rational voter will choose that option closer to itself.

Agents don't have memory because they don't have vote memory. The 11M event variable can take one ot the following values, the attack affect: nothing, a little, enough or a lot.

Interaction: There's no interaction between the voters. The interaction with the media is given by the distance to the source.

Stochasticity: We have considered random the auto-location of the voter in the spectre and the location they give to each party. The influence of the attack and the news is random in the sense that the voters are walking randomly in the world.

Collectives: Yes, the voters are divided in groups by vote intention. They are displayed in a histogram. The composition of these groups depends on the individual voting intention at each moment.

Observation: The amount of electors of each party in each moment.

3. Details

Initialization: At the initial state of the model, the real frecuency distribution of the

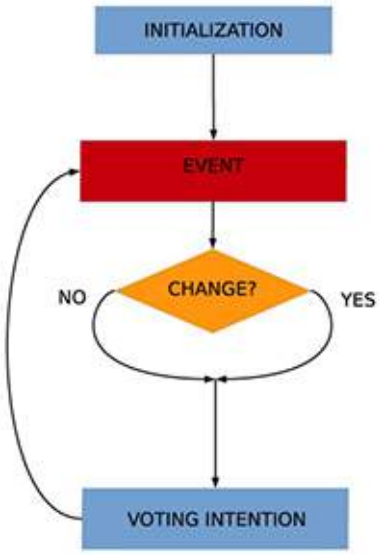
voting in the past polls is represented in the agents. It also can be changed to make experiments. The model is composed by 6.000 voters and 1 media source. The initialization state is always the same as it is driven by real data of the past polls.

Input data: Only at initialization, no data is consulted during runtime.

Submodels: Not present.

Simulation and experimentation: The only way we can show de validation of the model is with any poll preceded by a huge change in the society.

Flow chart:



Code: N6_code.nlogo
View it on Github: https://github.com/culturadigital/forma14/blob/master/N6.nlogo

Model snapshots:

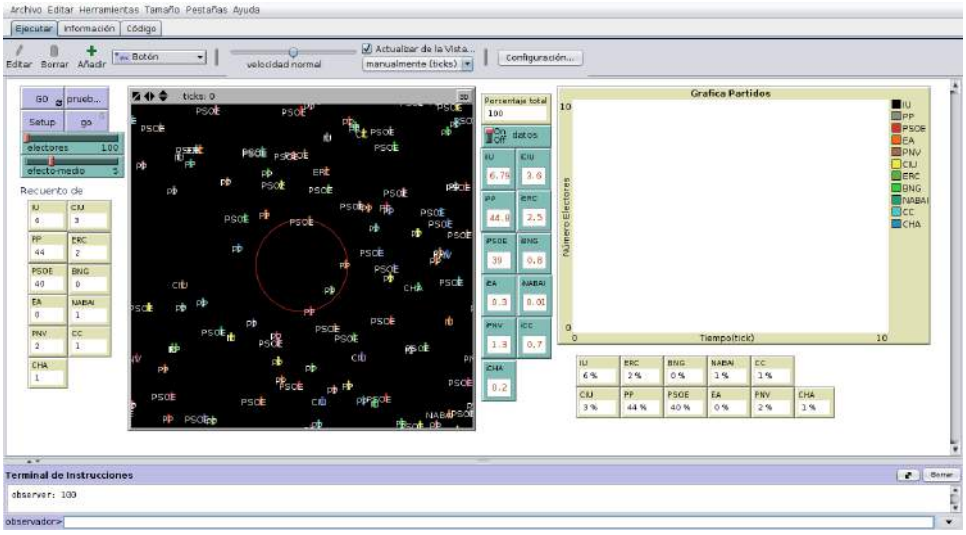


Figure 1. Initial state with real voting intention percentage

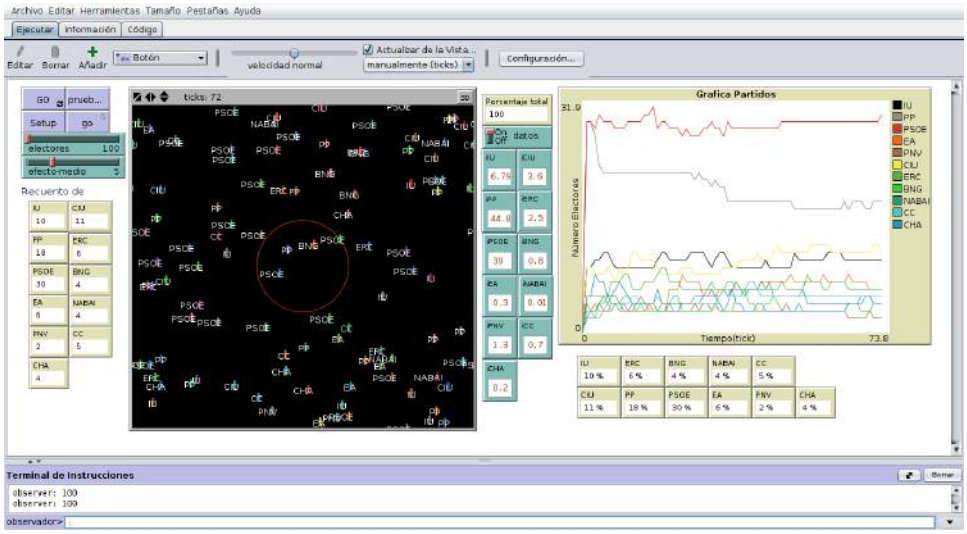


Figure 2. Simulation of 73 hours, as real time from 11M to 14M

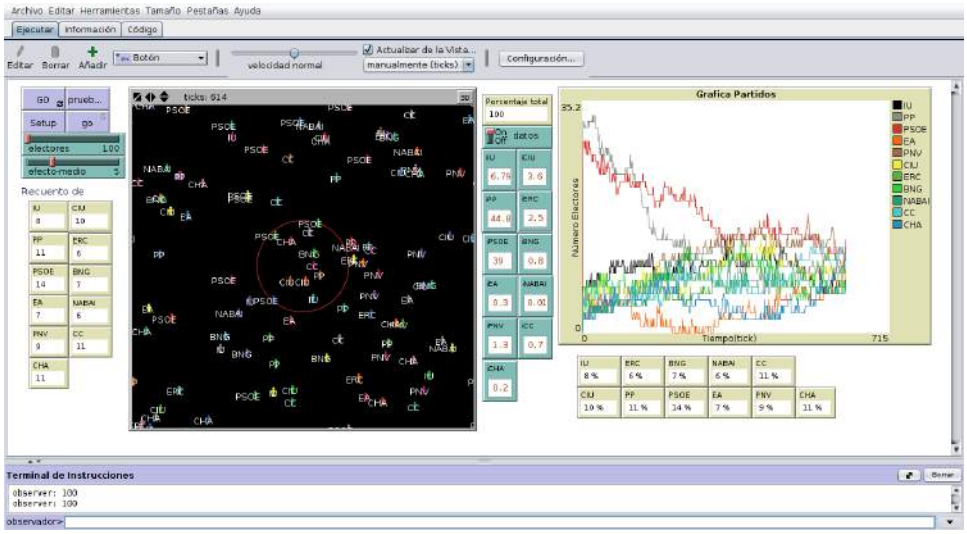


Figure 3. After a long execution the voting intention homogeinizes as in the model the differences are diluted

Conclusions:

- General elections of march the 14th of 2004 will be remembered as the elections in which the decision of the voters was conditioned by the terrorist attack of march the 11th. Even though the polls give the triumph to the PP (Partido Popular), at the end, the winner was the PSOE (Partido Socialista Obrero Español) with simple majority (not even the 50% of the votes).
- The post-electoral opinion studies made, don't allow us to determine the impact of the attack and the media response to it in the elector behaviour.
- Using NetLogo, we have been able to make an approach to that situation, not only of the effect of the attack, but also of the media impact between the days 11th and 14th.
- In the model, 6000 initial voters are distributed using the data of the last elections. From there, the agents perceive two state variables: the location that the agent give itself at the ideology spectre and the location each one give to each party. The attack of the 11th and the news and information published by media and official source are considered then enviroment variables. The obtained results show that the model explain quite well the added behaviour of the electors at 2004 elections.

References:

- Anderson, C. J., (2007), "The End of Economic Voting? Contingency Dilemmas y the Limits of Democratic Accountability". Annual Review Politic Science, 10, pp. 271-296.
- Downs, A., (1957), An Economic Theory of Democracy, Harper y Row, New York.

- Enelow, J. y M. Hinich, (1984), The Spatial Theory of Voting, Cambridge, Cambridge University Press.
- Jaime Castillo y Sáez-Lozano. El comportamiento electoral de los españoles. Centro de Estudios Políticos y Constitucionales.

N7. COUPLING BETWEEN MESSENGER RNA SYNTHESIS AND DEGRADATION DURING GENOME EXPRESSION

Authors:
Sebastián Chávez de Diego - Instituto de Biomedicina de Sevilla
schavez@us.es
David Pérez Aguado - Instituto de Biomedicina de Sevilla
María José Chávez de Diego - Universidad de Sevilla
Francisco Romero Campero - Universidad de Sevilla

Collaborators:
Daniel Corzo García
Concepción García Vidal
Pablo Canseco Ortiz
Juan Carlos Cuerda López
Daniel Jurado Sánchez
Javier Boza Farrán

Brief: Genome expression involves the synthesis of messenger RNA (mRNA), a short-lived molecule whose translation directs the synthesis of cellular proteins and that is subject to degradation after the translation process. Up to the date, mRNA synthesis and degradation has been considered as a linear phenomenon in which the above steps occur subsequently without a regulatory interconnection. However, gene expression can be studied as a global system in which all their stages are coupled and interconnected by regulatory mechanisms. We have contributed to demonstrate that the machineries of mRNA synthesis and degradation physically and functionally interact in the cell nucleus. We have proposed that it allows the cross-regulation of transcription with mRNA degradation and vice versa, giving rise to a circular system, which would explain the large robustness observed in gene expression (Haimovich et al, 2013).

Transcription is performed by RNA polymerase in cooperation with a set of auxiliary factors, and is divided into three phases: initiation, elongation and termination. During elongation RNA polymerase often undergoes a curious phenomenon of arrest where it translocates backwards with respect to both the DNA template and the RNA transcript, without shortening this one (Gómez-Herreros et al, 2012). This backtracking phenomenon can be reverted through the auxiliary factor TFIIS, allowing the resumption of mRNA synthesis. Experimental evidence obtained in our laboratory suggests that the backtracking process could imprint the synthesized mRNA, conditioning its half-life. Moreover, backtracked polymerases would be the regulatory targets of the mRNA degradation machinery when acting on the transcriptional process.

By using the NetLogo software, we have constructed a computational multiagent-based model of this system, using the main elements of the machinery of synthesis and degradation, as well as some of the auxiliary factors.

The minimal transcription/degradation system that we have modelled is composed of the following elements:

- RNA polymerase II; there are other RNA polymerases in eukaryotic cells but we focus in this because it transcribes protein-encoding genes. When RNA polymerase II is elongating mRNA can be either active or inactive (backtracked).
- TFIIS. This is the factor that promotes the reactivation of backtracked RNA polymerase II
- Ccr4 and Xrn1; these are the two main components of the mRNA degradation machinery. Xrn1 is a 5'-3' RNA exonuclease. Ccr4 is the main mRNA 3' deadenylase. In addition, Ccr4 is a transcription elongation factor that opposes RNA polymerase II backtracking.

The continuous variables of the system are the following:

- Total amount of RNA polymerases engaged in transcription
- Proportion of transcribing RNA plymerases that are active (non backtracked)

- mRNA molecules present in the cell
- Half-life of the mRNA

These continuous variables can be experimentally measured in a rather accurate manner. We have chosen GAL1, one of the best characterized genes of the yeast Saccharomyces cerevisiae, which is our favourite model organism.

The discrete variables of the system are the following:

- Presence of the mRNA degradation factors (Yes/No)
- Presence of the RNA polymerase II reactivation factors (Yes/No)
- Capability of the RNA polymerase II to become backtracked (Yes/No)

Xrn1, Ccr4 and TFIIS are non-essential proteins in yeast. The mutant strains lacking these factors are viable in standard growth conditions. When compared with the wild type, mRNA concentrations are surprisingly similar in these strains. The modelling of the system should allow explaining the robustness of the mRNA synthesis/degradation system.

This work is part of the project entitled "Crosstalk between transcription and mRNA degradation: influence of chromatin and RNA polymerase II backtracking", financed by The Spanish Ministry of Economy and Competitiveness (MINECO) (grant BFU2013-48643-C3-1-P). Although carried out in a yeast experimental system, the high degree of evolutionary conservation of gene expression mechanisms makes this work of general interest for Biology and Biomedicine.

Key question: Is there a cross-regulation between mRNA synthesis and degradation during genome expression?

ODD Protocol:
1. Overview

Goal: Modelling gene transcription and its coupling to mRNA degradation, to increase our knowledge on the molecular behaviour of this system and to test several alternative hypothesis based on previous experimental work.

Entities, process overview and scheduling: There are four kind of agents in the model: Gene, Polymerase, mRNA, TFIIS, Ccr4, Xrn1

- Gene promoter:
  - It does not move
  - Entry site of the polymerase into the gene
  - The promoter may have different levels of activity. This is modulated by Xrn1
  - It blocks its activity when a polymerase is transcribing the gene
- Gene body:
  - It does not move
  - It is downstream of the promoter
  - It is the informative part of the gen. It is copied into mRNA by the polymerase
- Gene terminator:
  - It does not move
  - It is downstream of the gene body
  - Exit site of the polymerase. In this the polyA tail is added to the mRNA and then the mRNA is released from the gene
- Polymerase:
  - Nanomachine that reads the information encoded in the gene body producing the mRNA molecule
  - It moves randomly in the cell
  - Enters the gene through the promoter
  - It may backtrack and arrest
  - Backtracked polymerases can reactivate by its interaction with TFIIS
  - It terminates transcription and mRNA synthesis at the terminator

- mRNA:

a. information (5')

- It is the body of the mRNA and contains the information encoded by the body of the gene
- It is polar: its two ends are different (3' end and 5' end)
- It is produced by the polymerase by reading the gene body
- It also contains a polyA tail in the 3' end
- It moves randomly in the cell together with the polyA tail
- Its polyA tail is degraded by Ccr4
- Its information (5' end part) is degraded by Xrn1, provided that the polyA tail is fully degraded
- It is characterized by its half-life (how fast is it degraded)

b. polyA (3')

- It is the tail composed by a high numbers of A nucleotides that is added to the mRNA 3' end immediately before termination
- It is fused to the informative part of the mRNA in its 3' end
- It moves randomly in the cell together with the informative part
- It is degraded by Ccr4
- Its degradation is a requirement for the degradation of the information part of the mRNA
- During transcription termination, it may be imprinted for degradation by the transfer of Ccr4 from the polymerase to the polyA

- TFIIS
  - It reactivates backtracked polymerases
  - It moves randomly in the cell
- Ccr4
  - It moves randomly in the cell
  - It degrades the polyA
  - After degrading the polyA it stays bound to the mRNA until this is completely degraded by Xrn1
  - When mRNA degradation is complete, Ccr4 acquires de capacity of interacting with the transcribing polymerase, keeping its degradation capacity
  - After interacting with the polymerase, it follows the polymerase until the terminator. Then it is being released and loses its transcriptional capacity.
  - In the terminator it switches back to the degration mode, losing its transcriptional capacity, and binds the polyA of the mRNA that is just transcribed
- Xrn1
  - It moves randomly in the cell
  - It degrades the information part of the mRNA (5' end) after the complete degradation of the polyA by Ccr4
  - After degrading the mRNA it switches to a transcriptional mode: it can stimulate the activity of the promoter, keeping its degradation capacity.
  - After stimulating the promoter, it loses its transcriptional capacity

The variables are absolute numbers, only the promoter activity and frequency of polymerase backtracking ranks between 0 and 1.

The spatial environment of model is the cell (3D) but It is not necessary a very high spatial resolution and we simplify to a 2D space. Your time interval is from t=0 mRNA concentration reaches a dynamic balance (steady state).

2. Design concepts

The model is based on our knowledge on the mRNA transcription and degradation phenomena. Two elements are especially relevant: The mRNA degradation machinery (Ccr4, Xrn1) can moves into the nucleus and influence gene transcription after mRNA

degradation. And the Polymerase backtracking is important for the coupling between gene transcription and mRNA degradation. Many specific molecular details of the degradation/transcription coupling are unknown. The purpose of the study is a first comparison of the global consequences of different possible options for some of these details.

Emergence: The steady state (dynamic balance) of mRNA concentration is an expected emerging result of the model.

Flow chart:

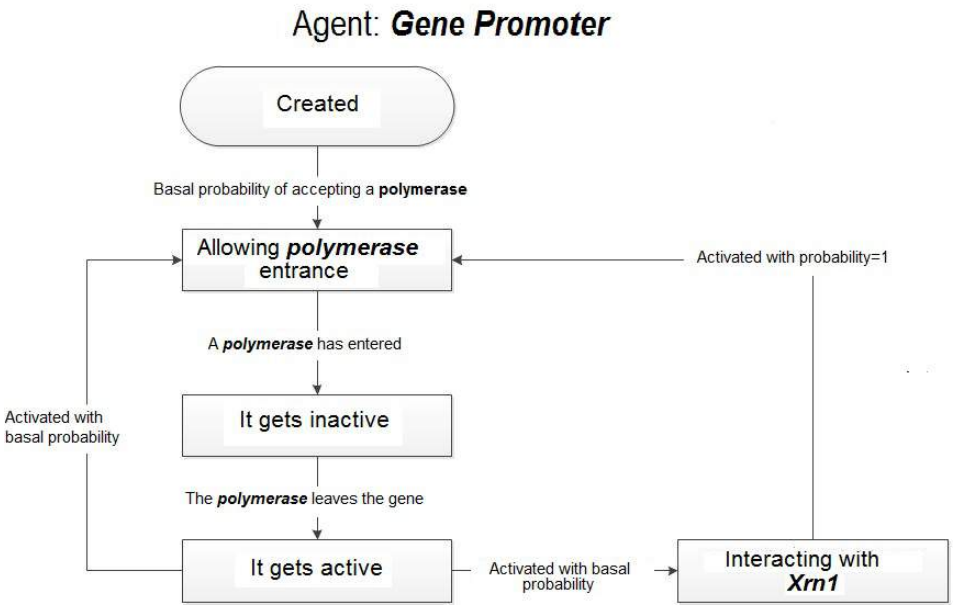


Diagram 1. Agent: Gene promoter

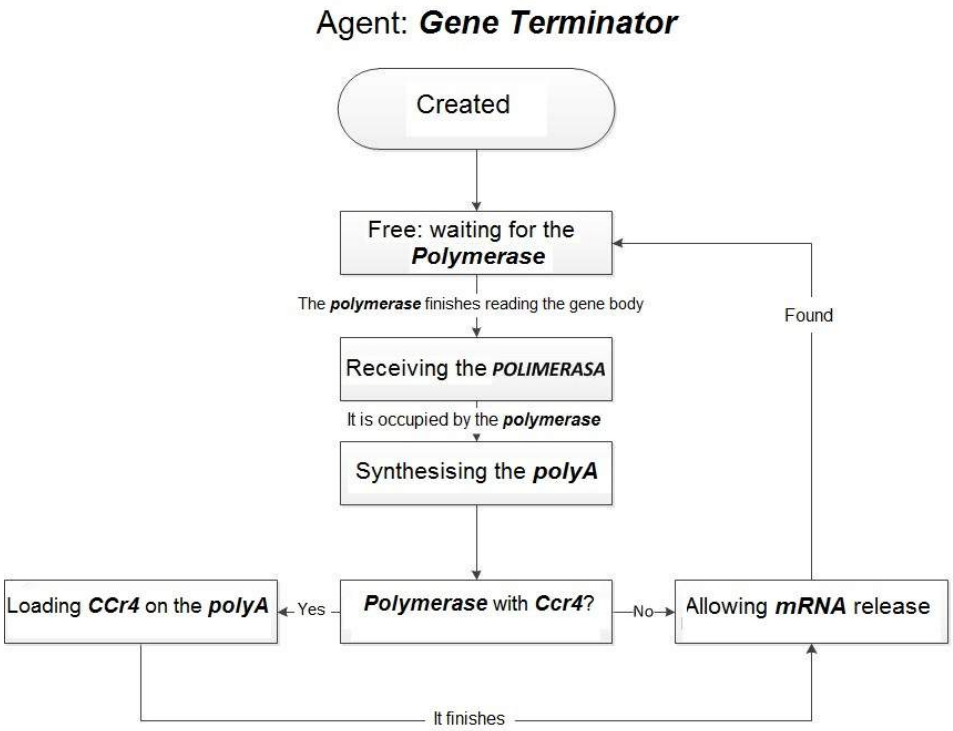


Diagram 2. Agent: Gene terminator

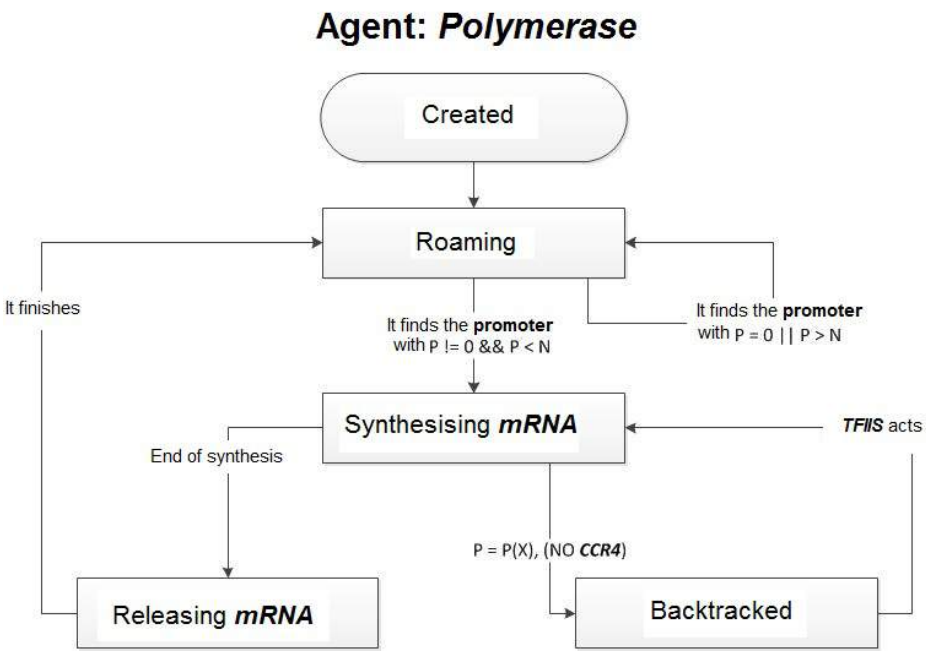


Diagram 3. Agent: Polymerase

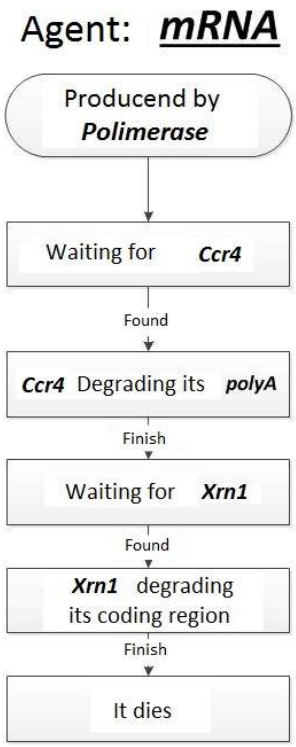


Diagram 4. Agent: mRNA

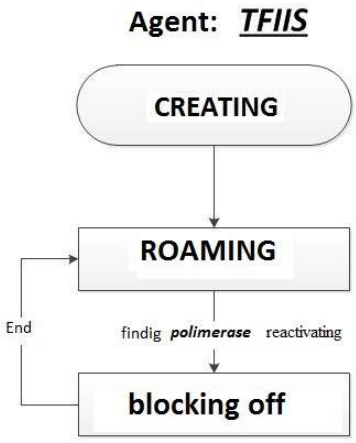


Diagram 5. Agent: TFIIS

Code: N7_code.nlogo
View it on Github: https://github.com/culturadigital/forma14/blob/master/N7.nlogo

Model snapshots:

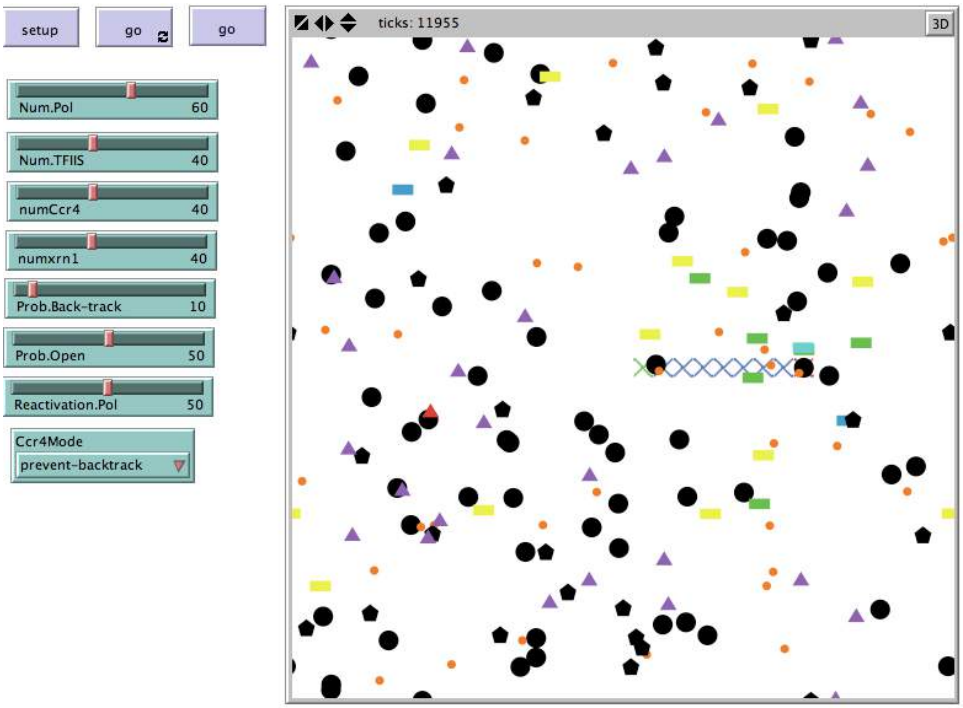


Figure 1. Symbols: X, gene; black circle, RNA polymerase; green rectangle, mRNA; blue rectangle, mRNA being degraded by Ccr4; yellow rectangle, polyA-less mRNA waiting for Xrn1; orange dot, TFIIS; black pentagone; Ccr4; purple triangle, Xrn1.

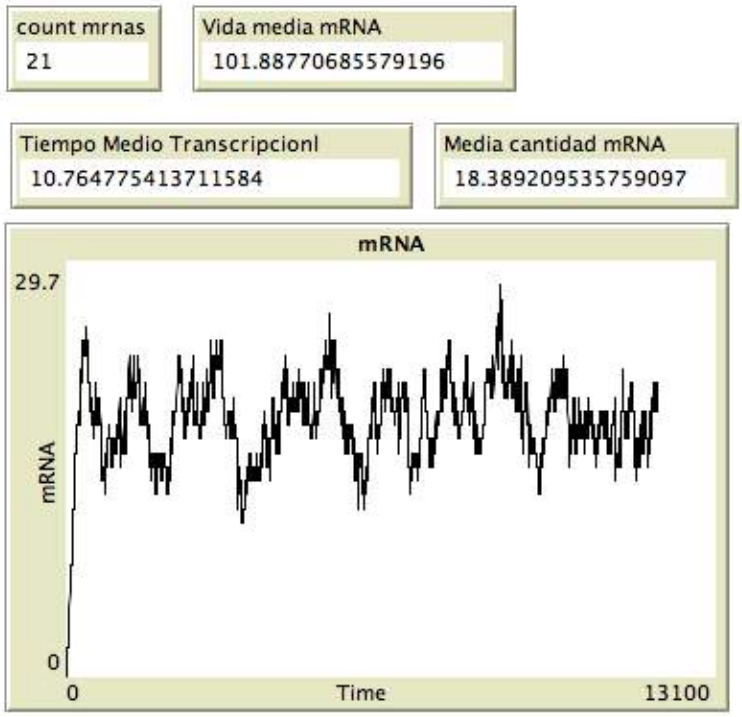


Figure 2. Graphic detail of the steady state (dynamic balance) of mRNA concentration.

Conclusions: By using the NetLogo software, we have developed a computational multiagent-based model of the mRNA synthesis/ degradation system. The results obtained support the expected behaviour for this system in the cellular context. These results, combined with experimental measurement of different variables of the system in mutant strains lacking the key genes of the process, should allow us better defining the synthesis / degradation coupling of mRNA and, in particular, confirming the importance of the backtracking phenomenon in this circular process.

References:

- Haimovich, G; Medina, D; Causs, S; Garber, M; Millán-Zambrano, G; Barkai, O; Chávez, S; Pérez-Ortín, JE; Darzacq, X; Choder, M. (2013) Gene expresión is circular: factors for mRNA degradation also foster mRNA synthesis. Cell. 153: 1000 - 1011.
- Gómez-Herreros, F; de Miguel-Jiménez, L; Millán-Zambrano, G; Peñate, X; Delgado-Ramos, L; Muñoz-Centeno, M.C; Chávez, S. (2012) One step back before moving forward: regulation of transcription elongation by arrest ans backtracking. FEBS Letters 586: 2820-2825.