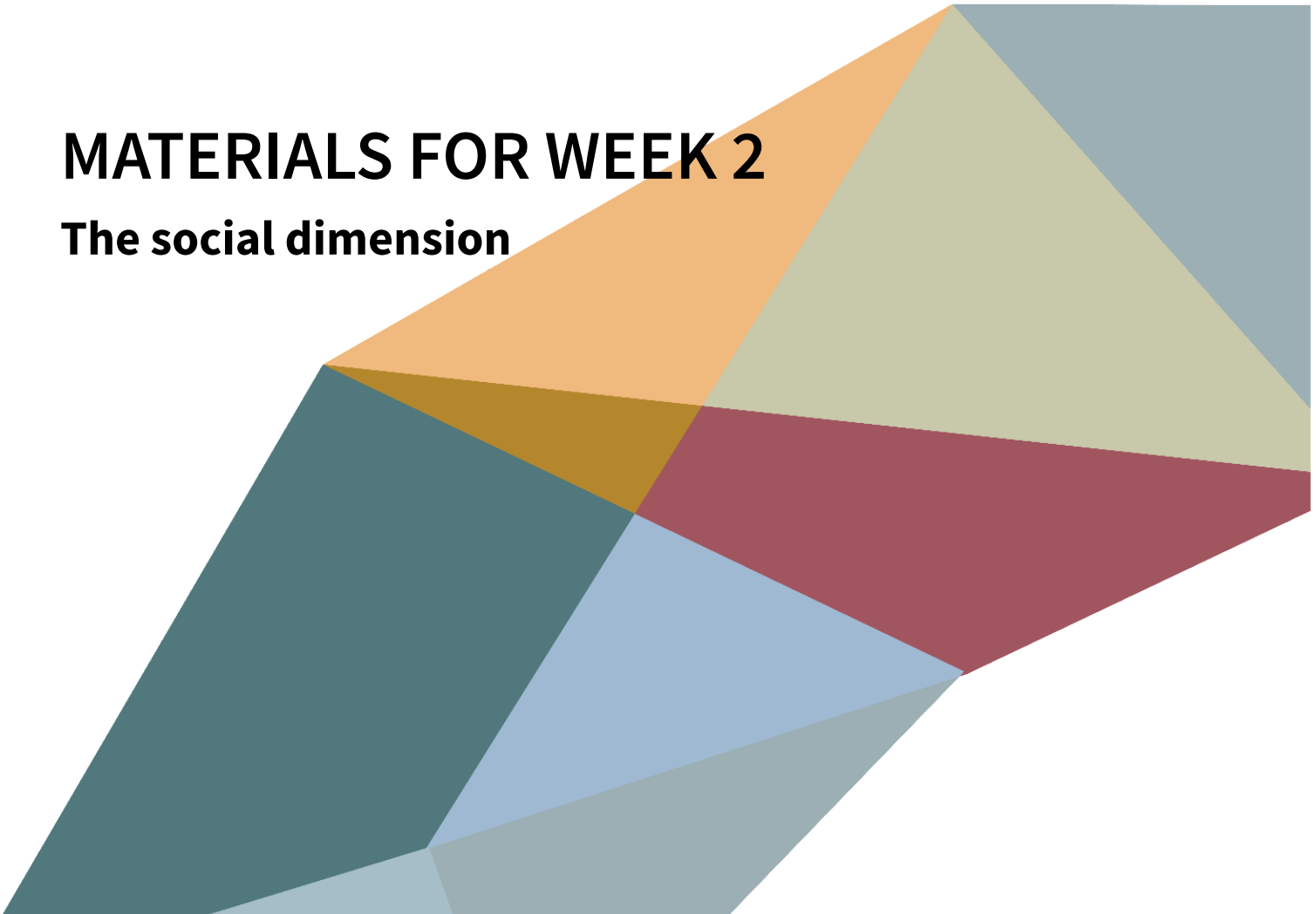
ACTISS
ACTION FOR COMPUTATIONAL THINKING
IN SOCIAL SCIENCES

THEMATIC COURSE

Decision Making in a Complex World: Using Computer Simulations to Understand Human Behaviour

MATERIALS FOR WEEK 2

The social dimension



THEMATIC COURSE

Decision Making in a Complex World: Using Computer Simulations to Understand Human Behaviour

MATERIALS FOR WEEK 1

The social dimension

Authors:

Wander Jager, University of Groningen

Katarzyna Abramczuk, University of Warsaw

Educational experts:

Esther Arindell, University of Groningen

Tom Spits, University of Groningen

In cooperation with:

Anna Baczko-Dombi, University of Warsaw

Agata Komendant-Brodowska (Project Leader), University of Warsaw

Nataliia Sokolovska, The Alexander von Humboldt Institute of Internet and Society

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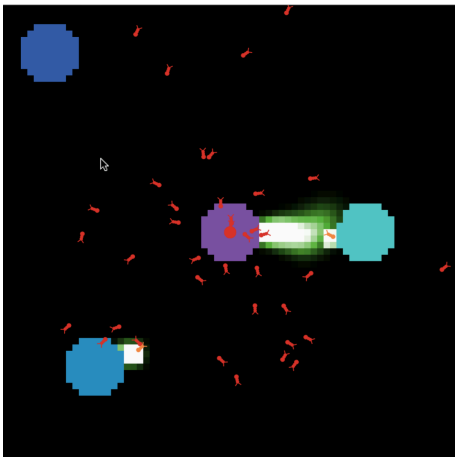

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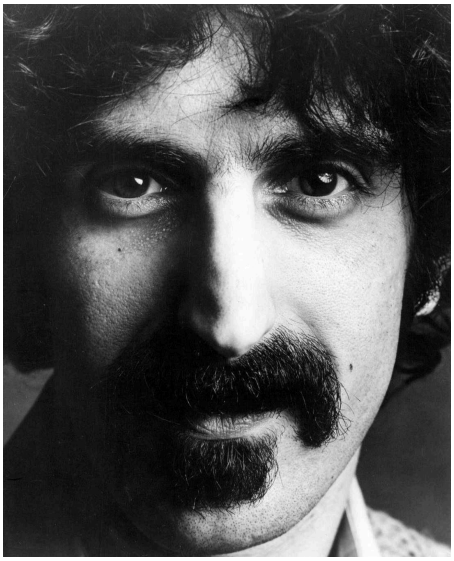

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In this week we experienced how simple models on norms and information sharing can produce interesting phenomena.

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Rounding up Week 2 – ARTICLE

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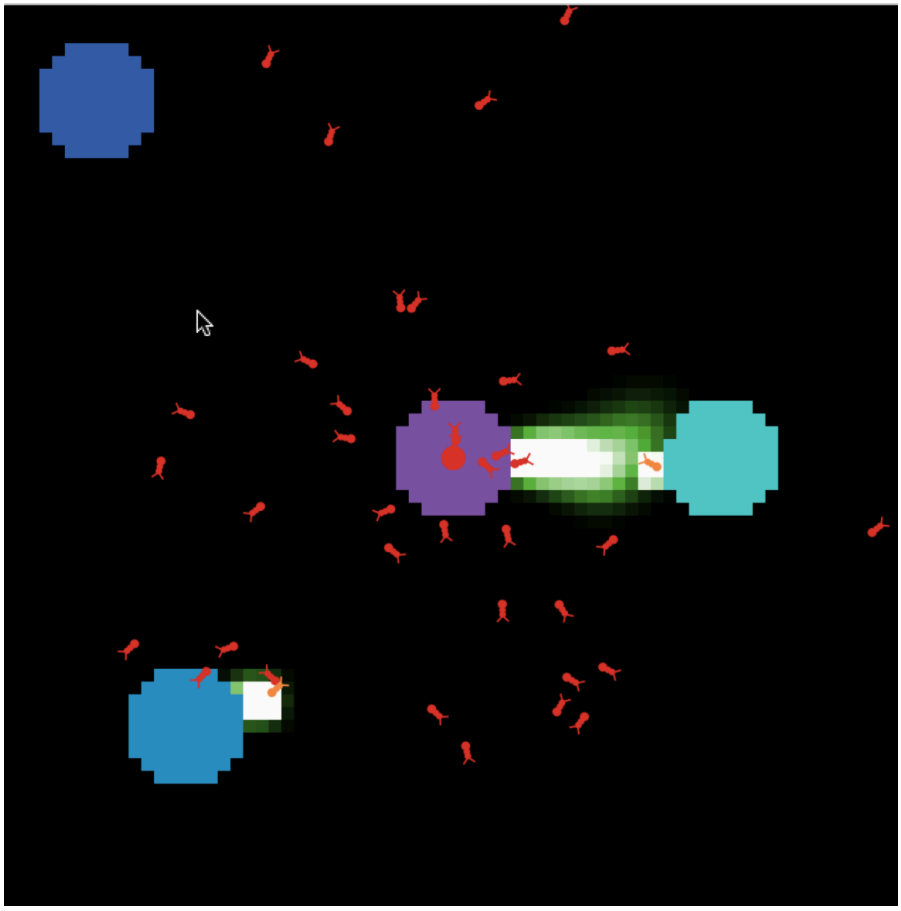
2.01 The sociality of people - VIDEO

Click on the icon to view the video

When we make decisions as humans, we take advantage of the information that is around us, to help us inform what the best decision is. In this video the social dimension of decision making is introduced.

2.01AA Human behaviour and decision making - ARTICLE



Simulated ant-agents exploiting food sources and leaving pheromone trails ©Netlogo ants model

This week we will be using a tool called Agent Based Modelling (ABM). In this step we will introduce you to how it operates.

ABM is a computational tool allowing for the modelling of many interacting individuals, called agents. To use it we need:

1. **agents** - this basically can be any individual: be it an ant, a tree, or a human
2. **a set of rules and characteristics of the agents** - these can tell us what agents are like (e.g. are they hungry, what they believe in) and what they do (e.g. how they move, how they make decisions)
3. **a set of rules and space/network for interactions** -. Many of these agents together can represent an ant-nest, a forest or a community/society. they can communicate, influence or …. eat each other.

The unique possibility ABM's offer is that we can equip the agents with rules for interaction. This means that the simulated ants, trees or people can react to the behaviour of other simulated ants, trees or people. Due to such interactions between individuals (micro-level), group phenomena (macro level) may grow (emerge). This opens new possibilities for studying group dynamics and processes of self-organisation.

As an example, the standard ant model in netlogo shows how ants, by just leaving a pheromone trail when they bring food to the nest, are capable of displaying collective intelligent behaviour by first harvesting the food

source closests to their nest. Whereas the simulated ants are not aware of their environment, as a collective they self-organise in such a way that the nearest food source is harvested first.

Also the behaviour of humans is targeted by many ABM's. For example, innovative behaviour and practices may spread, and opinions may polarise between subgroups.These group behaviours set the boundaries for individual behaviour. For example, if all agents believe in *X*, an agent believing in *Y* may experience a normative pressure to start believing in *Y* as well

Agent Based Modelling has been one of the most interesting methodological developments of the last decades for the behavioral sciences. Starting from computer science, artificial intelligence, and complexity science, it has matured to deal with genuinely social science aspects. Conducting experiments on artificial populations, social simulation provides a computational methodology to systematically explore how collective behavior arises from interactions between many individuals (emergence), and how in turn the behavior of a collective influences individual behavior (downward causation). The seminal work of Nobel laureate Thomas Schelling (1971) for example demonstrated that in an ethnically mixed society, where the individuals prefer merely not to be in a minority in their local neighborhood, a completely segregated society emerges as a result. Schelling's social computational model was one of the first where individual decision making, in this case the choice to stay or to move away from a location, was made dependent on the behavior of the other individuals, in this case neighbors staying or moving away.

More information and an exercise with the Schelling model of segregation can be found in the course on People, Networks and Neighbours: understanding social dynamics.

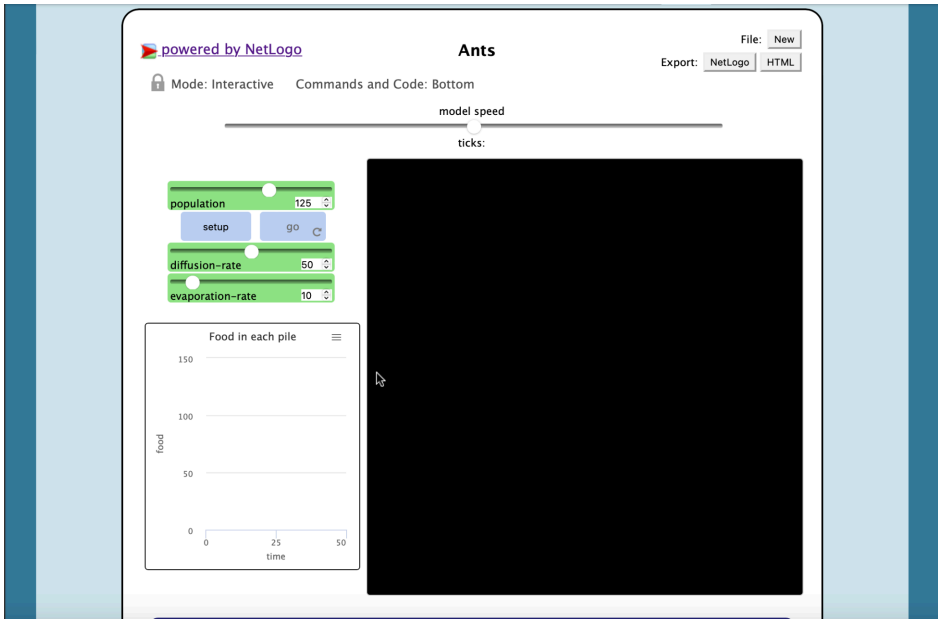
This ABM methodology opened a new perspective on studying social dynamic phenomena in coupled systems. However, translating bounded rationality into computational agent rules requires the formalisation of behavioural and psychological theories. This appears to be a big challenge.

In the following exercises we will be exploring how changing the set of rules by which agents decide what to choose can change the social outcome. This way, we can study how individual choices can change our predictions of social outcomes.

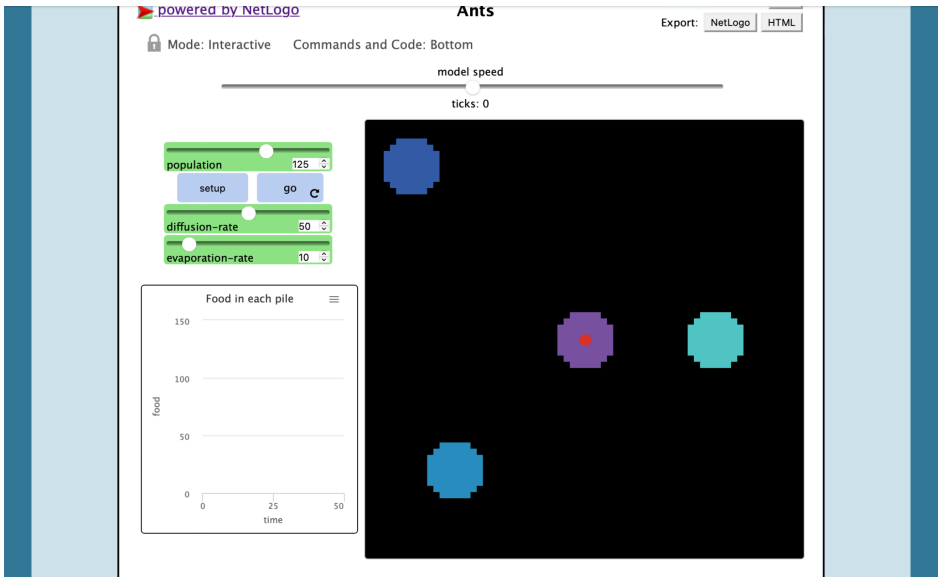
201 AB. A simple agent based model of ants - EXERCISE

In this exercise you will explore the simple agent based model of ants exploiting food sources. To open the simulation model you can click on the following link.

You will see the following screen:



If you click on “setup” you will see four circular shapes



The 125 simulated ants are living in the purple nest in the centre of the black square. Because they are all in the same place you see only one red dot representing the ants. The other three blue circular forms represent food sources to be harvested by the simulated ants.

When you click on “go” the ants will start walking around randomly through the space. Whenever they bump into a food source, they pick up a piece of food and bring it back to their nest. When doing so, they leave behind a pheromone (indicated by the light colour) that the other ants can smell. When other ants bump into the pheromone trail they will start following it, and hence find the food source, harvest, bring back the food to the nest, and add to the pheromone trail by also leaving a pheromone trail. The pheromone evaporates, so if the food source is empty, no new pheromone is added to the trail, and the pheromone trail disappears after a short while.

To observe: As you will notice, the ants quickly find the closest food source on the right hand side, and start to harvest that. When this food source is empty, they harvest the next food source in the left below corner. When that is empty, they will start randomly exploring again and find the most distant food source at the top left, and harvest that.

You can experiment with the diffusion rate and evaporation rate of the pheromone to see if this has an effect on the behaviour.

This simple agent based simulation demonstrates a key property of social systems: emergence. This means that the group as a whole displays some intelligent behaviour, in this case first the harvesting of the nearest by food source, despite the individual ants not having intelligence of the location of the food sources. Due to the communication between individual ants, intelligent behaviour emerges at the group level.

2.01A: Bringing in behaviour - VIDEO

Click on the icon to view the video

In this video we discuss the challenge of bringing in behavioural theory into agent based models.

[STORYBOARD TEXT IN SEPARATE DOCUMENT]

[FOLLOW UP QUESTIONS FOR LEARNERS TO HAVE THEM REFLECT ON THE VIDEO]

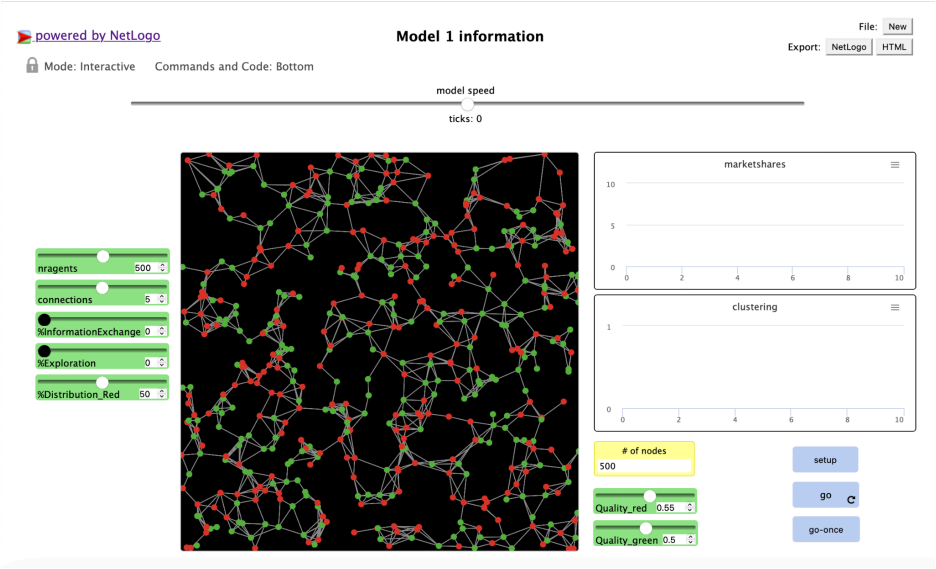
2.02A: A simple agent based model - EXERCISE

Choosing between a healthy apple and an unhealthy doughnut © Andres Ayrton on Pexels.com

In this exercise you will experiment with a simulation model where simulated people, so-called agents, are making a choice between two options: red or green. Just imagine they are selecting a hotel, and these hotels differ with respect to price, service and quality in our simple simulation example.

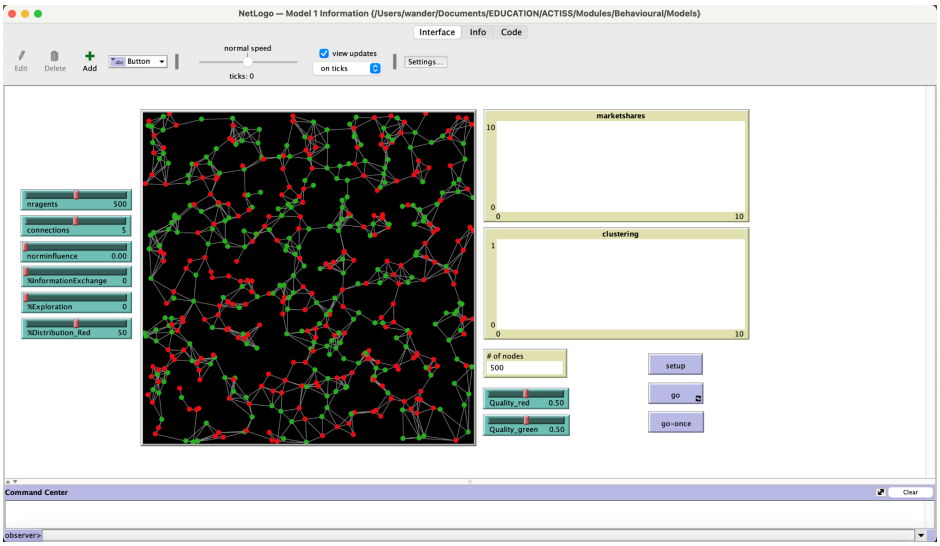
Setting up
You can run this exercise from the web by pressing the launch button at the bottom, or you can run it locally.

If you follow the link to the online version, and click on “setup” you will get the following screen:



The layout of the web version of the simple agent based model.

If you want to run the model locally, you can also download Netlogo for free from here. The **model 1 information.nlogo** can be downloaded here. If you have Netlogo installed, open it, go to "file/open" and search for the model in the location where you stored it locally. Open it, and click on "setup", you will get the following screen:



SCREENSHOT LOCAL VERSION HERE

What do you see?
You see 500 simulated people, the so called agents, that either use a red or a green product. In the sliders below you can adjust the quality of the products. These are now equal (.50).

These agents are connected with one another, so they can exchange information. In the default setting the agents have 5 connections.

You can change the quality of the products, but the agents need to find out about this. For this the agents can use two ways. First, they can just try another product and learn about its (changed) quality. With %Exporation you set the chance that an agent will try another product.

The second way is to ask another agent (one of 5 in the default setting) about the product they use. In this way an agent can also find out about the (changed) quality of products. With %InformationExchange you can set how often they ask other agents about their experiences.

You can also change the initial distribution of products using %Distribution_Red. In the default setting this is 50, meaning that 50% of the agents start with the red product, and 50% start with the green product. Setting %Distribution_Red at for example at 10 creates a situation where 10% of the agents start with red. This allows for exploring how a new product may enter an existing market.

Things to do
In the default setting the values of %InformationExchange and %Inquiring are set at 0. The agents do not explore nor exchange information.

This means that no new information is being processed, and the agents do not respond to changes in the products.

Experiment 1: default
You can change the quality of the red and green product, making for example the red product of a higher quality than the green product. You will see nothing is happening. This is because the agents just don't try other products nor ask others about their experiences.

Experiment 2: exploration
Now increase the %exploring to 10%. Change the product quality and observe how fast the agents learn about the better quality of the red product, and adopt that product.

Reflection: For some products people are more motivated to explore than for others. Think for example about toilet paper versus clothing. Do you think people differ with respect to their exploration behaviour? Think of some nice examples.

More simple agent based models - EXERCISE

People are connected through networks. In some situations networks are more relevant than in other cases. You can imagine that you will talk more often about clothing than about toilet paper.
But do the networks matter if people engage only in individual exploration, and do not communicate? Let's find out in the following experiment.

Experiment 3: exploration and networks
Repeat experiment 2, and vary the number of connections.

Reflection: You will see that it does not matter if the agents have a lot of connections or not, because exploration is an individualistic strategy.

2.02B: To explore or not to explore - DISCUSSION

Exploring ©Jelle van Leest via Unsplash

Exploration can happen in different ways. Some people enjoy browsing auction sites for products they like, other people enjoy walking through the city and do some window shopping. And some people do not like exploration at all.

Do you often engage in exploration? And if so, for which types of products do you spend more time to explore? And for what type of products you don't explore at all? Can you explain why people differ in how much time they spend on exploration?

2.02C: Continuing with a simple agent based model: information sharing - EXERCISE

In this exercise you will continue to experiment with the simulation model from the previous exercise.

Here you will experiment with the influence of agents sharing information with each other. This means that an agent can learn from another agent about the quality of a product. Imagine you use the red product because you think that the quality of green is worse. This may for example be on the basis of a previous experience. However, the green product may have been changed, and its quality now may be better than the quality of the red product. Through %InformationExchange we can let the agents share their experience with the products. Hence you can learn from a connected agent that currently the quality of green is higher than the quality of red.

Things to do
In the default setting the values of %InformationExchange and %Inquiring are set at 0. The agents do not explore nor exchange information. This means that no new information is being processed, and the agents do not respond to changes in the products.

Experiment 4: sharing information
Set the values of %InformationExchange at .10, %Inquiring at 0 and connections at 1. The only way the agents can learn about a changing product quality is through connected agents using this product (informational influence)

Set the quality of green and red at .50. Start the simulation (run), and then change the quality of red to .60.

How quickly does the red product diffuse? What is the resulting market share?

Now repeat this experiment several times, increasing the number of connections to 2, 3, 4...10.

How important is the connectivity of the network for the spreading of information? And explain why in the cases with a low level of connections groups remain that continue using green, despite red offers a better quality.

Diffusion - EXERCISE

In the previous experiments we started with an equal share of both products, ideas or opinions. But mind that new products, opinions and ideas always grow from a minority position. So it is of interest to explore how the precious experiments turn out if for example red starts from a minority position.

Experiment 5: diffusion

In this experiment you can repeat the experiments 2, 3 and 4, but now starting with Set %Distribution_Red at 10.

In this situation the red product starts with a small market share, and it is of interest to explore how exploring, informational exchange and connectivity together influence the speed and degree with which the red product may conquer market share when its quality is superior.

2.03: Social decision making - DISCUSSION

Happy people standing together *© Pict by Helena Lopes: Unsplash*

In the previous exercise you explored a simple agent based model where the simulated people could make a choice between three products.

As you noticed, the agents were connected through a network, and they could inform each other about the attributes of the product. Hence there is sociality in the model.

Also you explored the difference between products, ideas or opinions starting from an equal position (experiment 4), or having the red one start from a minority position (experiment 5).

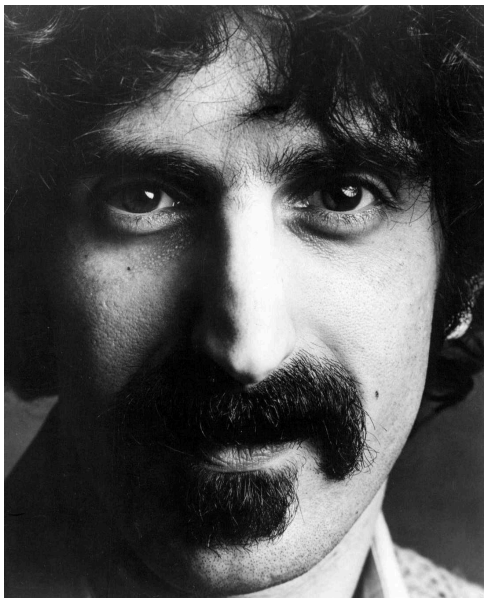
In the model, the social influence that people exert on each other is purely informational. However, our sociality is richer than just sharing information.

How does our sociality affect our decisions when we for example choose:

- what brand of shoes or clothes to buy?
- what food we prefer
- what to wear at a formal ceremony (wedding, graduation)
- to take or not a vaccination

Do you sometimes comply with the behaviour or opinions of others, even if your private preference or opinion may be different?

2.04 The sociality of people - VIDEO



Frank Zappa (CC BY): https://commons.wikimedia.org/wiki/File:Frank_Zappa_1973_2.JPG

Click on the icon to view the video

In this video we discuss the sociality of people. We will discuss the principles of social learning, imitation, norms and conformity. In the following exercise, we want you to consider how to model norms.

The videos mentioned in the video are the following:
Tom Hanks in Cast Away: https://www.youtube.com/watch?v=Z-365iujWk8
The chimps banana and ladder experiment: https://www.youtube.com/watch?v=WkT0BtfOB-M

The classic Asch experiment: https://www.youtube.com/watch?v=TYIh4MkcfJA

[TEXT IS IN STORYBOARD 2.04]

Have you ever encountered a situation where you followed the group, despite your personal opinion or preference being different? How did that feel? Do you have (historical) examples of how conformity to the group may cause problems? And can you come up with an example of how following the norm can be beneficial? Please share with other learners in the discussion section.

2.05: How to implement a norm - DISCUSSION

Traffic light © Jos van Ouwekerk on Pixabay

Norms come into play when other people see your behaviour, and you may feel a need to conform to what most people do. Imagine you are encountering a red traffic light for pedestrians. You can decide to wait for the green light to show up, but you can also decide to ignore the red light and cross the street.

How likely is it that you would ignore the red light in these six situations:
1: The bus you need to catch is almost leaving from the other side of the street
2: It is late at night an nobody is on the street

3: There is no traffic, but several people are patiently waiting for the traffic light
4: A respectfully looking person is crossing the street whilst ignoring the red light
5: A shabby looking person is crossing the street whilst ignoring the red light
6: A large majority of people is crossing the street despite the red light

What do these answers tell you about the different outcomes that are important for you when respecting or neglecting the red traffic light?

2.06: The modelling of norms - VIDEO

Click on the icon to view the video

[TEXT IS IN STORYBOARD 2.06]

[ONE OR TWO QUESTIONS FOR THE LEARNERS TO RESPOND TO]

In this video we discuss the normative sensitivity of people and how to model that. It is being explained that people are heterogeneous concerning their sensitivity for norms. Moreover, similarity and reputation of other people play an important role in their social influence.

2.07: Norms in agent based modelling - ARTICLE

Norms ©Mareko Tamaleaa on Unsplash

HOW NORMATIVE INFLUENCE WORKS

Suppose you are in a hurry for a meeting, and you encounter a red traffic light for pedestrians. Do you cross the red light, or do you wait for the green light to show up? It will surely matter if other people cross the red light or not.

This behaviour relates to following social norms. Norms are one of the key drivers of behaviour, and essential to understand social influence. In the field of social psychology, abundant research has been conducted on how norms operate and influence human behaviour.

Basically, compliance to norms serves three goals. First, norms may inform us about **what behaviour is accurate** in a given situation. When for example many people cross the red light, you may assume there is no danger involved, and following the norm thus assumes this is a correct action to take. Second, following the norm may contribute to having **meaningful relations**. When you deviate too much from the norm (e.g. wearing shorts and flip flops at a formal reception) other people are less likely to interact with you in a positive way. Finally, abiding by societal norms may contribute to your **self-concept** as being a person with a consistent set of values on what to do and what to avoid.

Modelling norms is a critical challenge in agent-based modelling, as normative influence is one of the key mechanisms of social influence. Say you are walking in a city and you encounter a red traffic light at a road

crossing. If all other pedestrians wait for the red light, the norm will be to wait as well. However, if all people cross the road despite the red traffic light, it is likely that you will cross as well. If only half of the people do not respect the red traffic light, the norm is unclear, and possibly your personal norm may take over.

Also, your personal situation may play a role. If you are late for an important meeting, and it is starting to rain, the norm will be less important to you than if you are just leisurely walking around in the city. Your personality may play a role. If you are in general less susceptible to the behaviour of others, or even like it to be different, you may cross the red light if only a few or even nobody crosses the red light. And to complicate things further, the similarity of other people disrespecting the red light may have an impact as well. If well dressed and high-status people cross the road you might be more inclined to follow them than if a few poorly dressed or deviant people cross the street. This shows that even in this simple situation several aspects may determine the normative pressure you experience.

How to model normative influence

A very simple implementation of normative influence can be based on a weighting function where a distinction is being made between personal and social outcomes of performing a particular behaviour. Let's continue with the traffic-light example.

The personal outcome relates to the multi-attribute outcomes of either crossing the red light or not. For example, crossing the red light will make sure you will be on time for this meeting, and avoid getting too wet from the rain, but there is a risk of getting a fine from the police. On the other hand, waiting may result in arriving late and wet at the meeting, which may have a negative impact on your career.

To model this situation we can use for example multi-attribute utility functions for a specific person and situation that weight various important factors. For example, such a utility function can depend on (1) the personal utility of crossing the red light (being on time & dry at the meeting), (2) the utility of following others t, and (3) the utility of following a norm. The more important a person finds the social norm, and the less important the importance of the personal outcome are, the more likely it is the person will act the same as other people: disrespecting the red light if a majority walks through the red light, and waiting for green light if most others do so.

Agent based modelling is well known for its capability of dealing with heterogeneity in the population. Personality differences with respect to normative susceptibility can be implemented in agent based models. You can imagine that in the process of innovation diffusion, where a new product or practice is being introduced, especially the people that don't abide too much to the norm may be the first to try and adapt a new behaviour. They basically focus on their personal utility. The more people adopt the new behaviour, the stronger the social norm gets. Once a critical mass of people has adopted the new behaviour the adoption process will amplify itself like a sort of "*social avalanche*".

Obviously many extensions from the above simple idea are possible. For example, the visibility of the behaviour is important. Clothing and cars are obviously socially more meaningful than toilet paper and table salt. Also of importance is the reputation of those people deviating from the norm. When a famous artist or reputable citizen deviates from the norm, e.g. by propagating a plant based diet or endorsing a specific brand, it will have more impact than if a disrespected person engages in the same behaviour. Rosaria Conte and Mario Paolucci have dedicated years to study how norms can be implemented in agent based models. And keep in mind the wise words of Frank Zappa: "Without deviation from the norm, progress is not possible"

For a more detailed example of modelling norms, including some simple exemplary formulas, I recommend this paper.

Read more:

Neumann, Martin (2010) 'Norm Internalisation in Human and Artificial Intelligence' Journal of Artificial Societies and Social Simulation 13 (1) 12. doi: 10.18564/jasss.1582

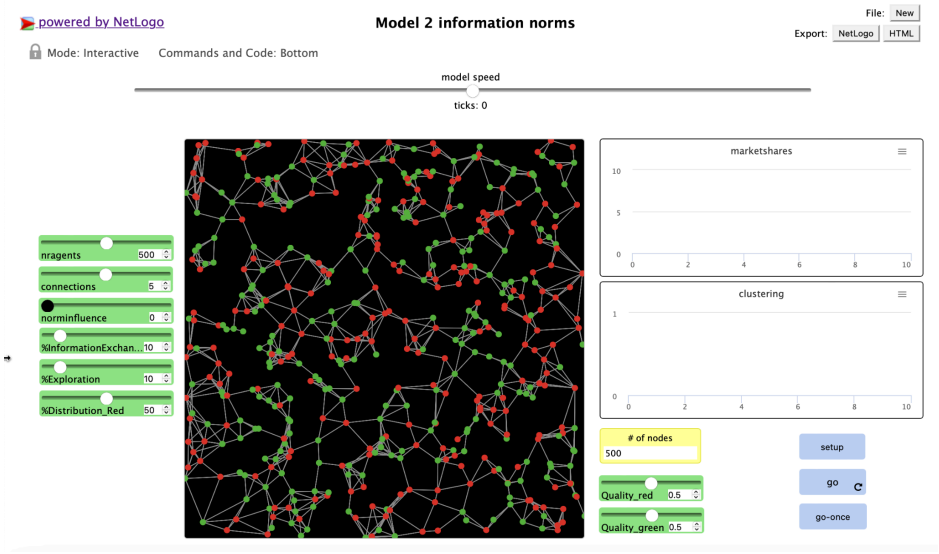
Jager, W. (2017). Enhancing the Realism of Simulation (EROS): On Implementing and Developing Psychological Theory in Social Simulation. *Journal of Artificial Societies and Social Simulation 20 (3) 14*. doi: 10.18564/jasss.3522

2.08: The impact of norms - EXERCISE

In this exercise you will experiment with the same simulation model as in the previous exercise 2.02, only in this experiment we will add norms influencing the behaviour of our agents. We choose a very simple model of norms: an agent has a social utility, which is more satisfied if the behaviour of the agent is similar to the behaviour of the other agents.

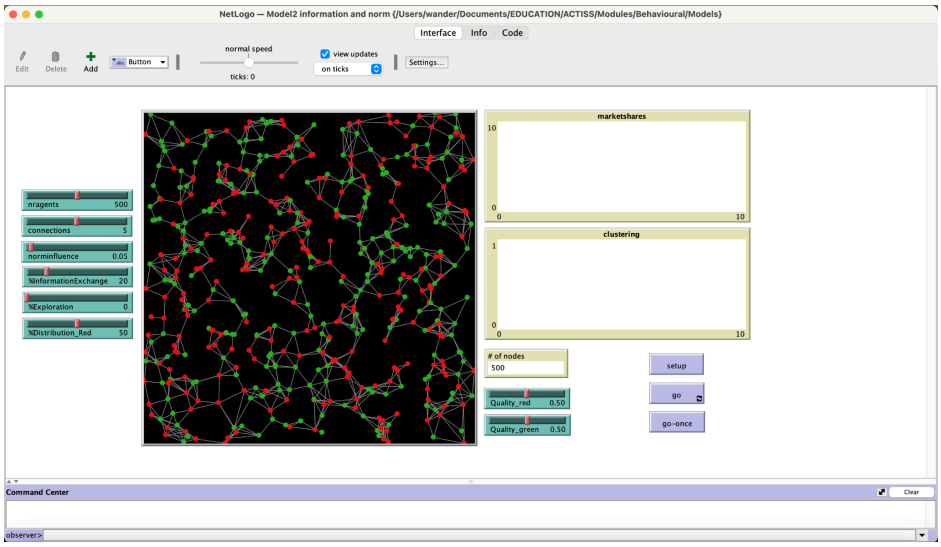
Setting up
You can run this exercise from the web by pressing the launch button at the bottom, or you can run it locally.

If you follow the link to the online version, and click on “setup” you will get the following screen:



The layout of the web version of the simple agent based model.

If you want to run the model locally, you can also download Netlogo for free from here. The **model 2 information and norm.nlogo** can be downloaded here. If you have Netlogo installed, open it, go to “file/open” and search for the model in the location where you stored it locally. Open it, and click on “setup”, you will get the following screen:



The layout of the local version of the simple agent based model.

What do you see?
You see 500 simulated people, the so called agents, that either use a red or a green product. In the sliders below you can adjust the quality of the products. These are now equal (.50).

These agents are connected with one another, so they can exchange information. In the default setting the agents have 5 connections.

You can change the quality of the products, but the agents need to find out about this. For this the agents can use two ways. First, they can just try another product and learn about its (changed) quality. With **%Inquiring** you set the chance that an agent will try another product.

The second way is to ask another agent (one of 5 in the default setting) about the product they use. In this way an agent can also find out about the (changed) quality of products. With **%InformationExchange** you can set how often they ask other agents about their experiences.

New in comparison to the previous exercise is the introduction of norms. With the slider **norminfluence** you can define how important it is for an agent to use the same product as the other agents they are connected with. Hence the utility of a product is not only determined by the quality, but also by who else is using this product. The higher the value of norminfluence, the more important the norm is in comparison to the product utility. Ultimately, when norminfluence is set at 1.00, the quality of the product is not affecting them at all.

Things to do
In the default setting the values of %InformationExchange and %Inquiring are set at .10. The agents do explore and exchange information. Norminfluence is 0 in the default setting.

Experiment 1: the effect of norms

Click on go to start the experiment. Now change the quality of the red to .60. making it of a higher quality than the green product. You will see that the red product will immediately conquer market share.

Now set the norm at .10 and the quality of red to .50 and click on go to start a new experiment. What do you observe?

Now increase the quality of red slowly to around .80, and wait till the green product has a minority share. Why are there still agents using green?

Now gradually decrease the quality of red. You will see that the red product will still have the largest marketshare despite being of (slightly, e.g. .40) lower quality than the green product.

Now further gradually decrease the quality of red and/or increase the quality of green. At one moment you will see that the green product is quickly taking over.

How does the green product spread through the community?

What does happen with the normative influence during this change?

2.08B: The impact of norms on a denser network - EXERCISE

Experiment 2: norms in a denser network

Networks connecting people are sometimes very actively used, for example when people talk about fashion, politics or food. Other issues may hardly be discussed with other people, such as toilet paper, one's monetary situation and other private issues. In the previous experiment the agents had 5 connections, now we double that to see if a denser network activity has any effect.

Set %InformationExchange and %Inquiring again at .10, norminfluence at .10 and connections at 10. Now we have a much denser network than in the previous experiment.

Run this experiment a few times and observe what is happening.
Now run an experiment, and wait for a situation where one product is conquering more marketshare (you might to restart the mode a few timesl to let the simulation produce such an outcome). Now make the product with the lower marketshare a bit more attractive by setting its quality at .55, or .60 in case the process of change stops. Mind that the process of change may be slow, so be a bit patient when running this experiment.

What do you observe concerning the development of the marketshare?

Rerun this experiment often to get a good feeling for the dynamics of change under conditions of normative influence. Explore how stronger norms (e.g. .20 or higher) have an impact on the sensitivity of our artificial population for quality changes in products.

2.09: How to model norms more realistically? - DISCUSSION

Graffiti the norm? ©Micael Navarro via Unsplash

In the previous steps you have been exploring a model with norms influencing choice behaviour. The model is obviously way simpler than the normative influences taking place between real people. Also the network structure is a simplification of real world networks.

- What suggestions do you have for making the normative influence more realistic?
- Would it be of interest to have some agents deliberately deviating from the norm? Why?
- What additional experiments can you think of?

For more information on network structures and properties we refer to the module on social network analysis.

2.10 Rounding up Week 2 - ARTICLE

Simulation of the city population of Groningen ©University of Groningen

In this week we experienced how simple models on norms and information sharing can produce interesting phenomena. Next week we explore how more theories can be integrated in simulations, and see how they can be used in a real case.

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