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 3

Integrating decision making into models

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OVERVIEW OF THIS WEEK'S MATERIALS

In the previous week, we started slowly to include new elements into the simulations. We added exploration, information exchange, normative influence and network density as factors. This week we will explore a bit deeper what different aspects of human decision making and behaviour can be integrated in computational models.

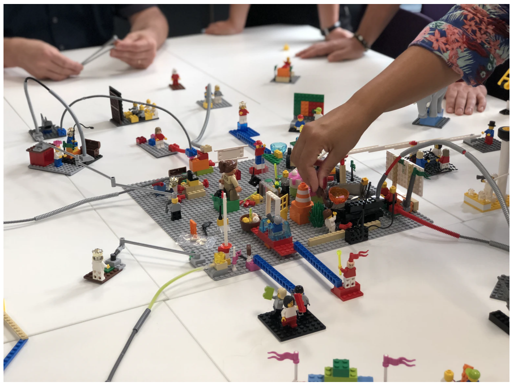
STRUCTURE OF THIS WEEK'S MATERIALS

Integrated models
Welcome to Week 3. In the previous week, we started slowly to include new elements into the simulations. We added exploration, information exchange, normative influence and network density as factors. This week we will explore a bit deeper what different aspects of human decision making and behaviour can be integrated in computational models. And this can be quite a puzzle.

STEPS:

Introduction week 3 – ARTICLE

Classical Choice Theory



STEPS:

Integrating models of human behaviour – VIDEO

Integrating theories into agent-based modelling – ARTICLE

A simple agent based model (heuristics) – EXERCISE

How do habits affect our choice behaviour? – DISCUSSION

A simple agent based model (heuristics) – EXERCISE

Further integration, the impact of habits on diffusion of innovations – DISCUSSION

HUMAT, an example of an integrative model - VIDEO

HUMAT, an integrated model - ARTICLE

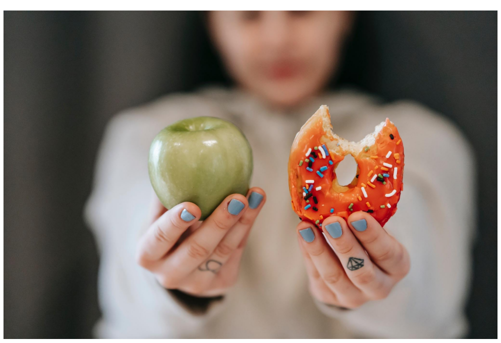
What societal issues can be addressed? - DISCUSSION

How realistic should a model be - VIDEO

KISS and EROS: On realism versus simplicity of models - ARTICLE

Are ABM's the new dynamical theories? - ARTICLE

Course conclusion



STEPS:

Wrap up – VIDEO

What next? – ARTICLE

EDUCATIONAL MATERIALS

3.01 Introduction week 3

3.02 Integrated models of humans - VIDEO

[TEXT HAS BEEN MOVED TO STORYBOARD 3.02]

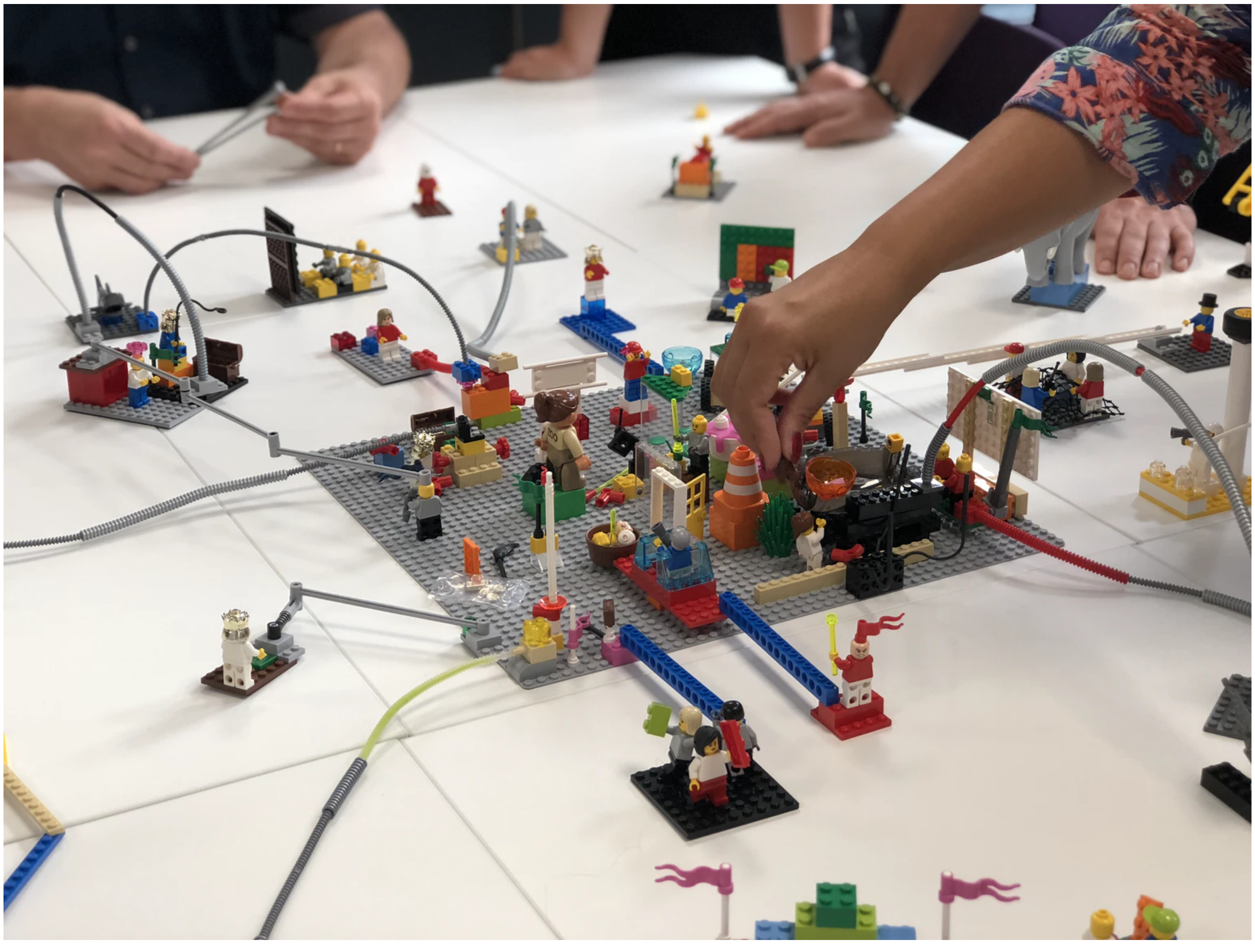
[WE NEED ONE/TWO REFLECTIVE QUESTIONS ON THIS VIDEO]

In this video, we explain why integrated models of human behaviour are needed in computational social science.

Do you think all aspects that make us human, such as emotions and intuition, can be represented in a computer simulation? Why (not)?

Do you think integrated computational models open new horizons for studying human society? What societal problems could be studied using such models?

3.03: Integrating theories into agent-based modelling - ARTICLE



Integration ©Amélie Mourichon via Unsplash

500-700 words

Todo: Connect with the later text on if ABM's are theories

~~HOW WHAT PEOPLE DO MAKES WHAT SOCIETIES BECOME~~

Many societal issues display emergent phenomena (see the introductory course on People, Networks and Neighbours: Understanding Social Dynamics for an article on the social dynamics of this). Hypes, opinion dynamics and polarisations, the diffusion of new technology, these are all phenomena growing out of the manifold interactions between people.

To better understand the dynamics driving such societal issues, we can study the interactions between individuals and the group(s) they belong to. This addresses the so-called micro-macro dynamics in society. Because these dynamics can display tipping points, and may display unpredictable turbulences, understanding these are contributing to understanding and guiding societal change.

Examples of such changes are growing a society towards a more plant-based diet, the opinion formation and behavioural response to a disease (e.g., COVID, obesity), or migration and acculturation in relation to climate change and armed conflicts. Improving our understanding of these so-called micro-macro dynamics may help to think of policies preventing social dynamics from spinning out of control.

HOW TO MODEL PEOPLE

A key challenge in the use of agent-based models is modelling relevant behavioural processes in a valid manner. We know that we are not only outcome maximisers, but also use several smart (bounded rational) strategies to make good-enough choices with our limited cognitive capacity. As humans we are equipped with different "fast and frugal" strategies to make choices in a world that is demanding constant choices from us. Gerd Gigerenzer describes this as an adaptive toolbox we have (formal models of heuristics) for solving problems in situations of uncertainty where an optimal solution is unknown. In other words, how people decide will depend on the decision content and context.

When we want to simulate the behaviour of people in an agent-based model, a key question is what mechanisms and associated theories can help us construct "artificial people" that perform the behaviours we are interested in? The answer to this question depends for a large part on the scope of the behaviour in question. Our dietary choices are, for example, very determined by the habits we have. This means that new information is less likely to be picked up, and people will be quite persistent in their behaviour, even if better alternatives are available. When we want to model this type of choices we need to assume a process in which the status quo plays an important role.

On the contrary, when buying a car people usually invest a lot of cognitive energy in scrutinising and comparing their options. Many models are available in a wide price range, and many attributes require some careful processing. For example, when a person is in doubt between a fuel or electric car, the available charging infrastructure definitely is a relevant aspect in decision making. However, for many people a car is also an expression of one's taste and personality, and so the social context will be relevant to consider in a model. And mind that for many people a car is impractical or too expensive, and alternative mixes of modalities like public transportation, biking and car-sharing can be part of the decision context. So, when we think of modelling the dynamics of car purchasing in a time of energy transition, we may start with the Theory of Planned Behaviour, as this combines the multi-attribute perspective (attitudes), the influence of norms (subjective norm) and behavioural control (e.g., budget, charging infrastructure) as key drivers.

Agent-based modelling offers the computational tool for systematically studying emergent social dynamics. Hence, in recent years this methodology is increasingly being used to study a wide range of societal dynamics. In the Journal of Artificial Societies and Social Simulation a plethora of articles address a wide variety of societal phenomena being studied with agent-based models.

When a new topic or question arises where understanding the possible social dynamics comes in handy, it is smart to build upon earlier models that have been developed, used and published. The basic psychological and behavioural mechanisms are usually the same, and can be applied to new topics. As a natural consequence, models become available that combine different factors and processes, and that are generic enough to be used for different research topics.

We may think of starting from scratch when developing an appropriate model for a new case. However, because the theoretical principles underlying our behaviour are widely applicable, we may also use a modelling framework that integrates several behavioural mechanisms.

Such a framework serves as a template for constructing artificial societies and the issue(s) that are being modelled. It also helps in reflecting on which mechanisms to include in a specific case model. Think of processes such as communication and persuasion (%informationExchange in the exercises)), befriending people (network formation) or habit formation. Once a mechanism has been implemented in a case model, it can easily be transferred to comparable case models. Code is often easy to copy in other models.

Actually, the Theory of Planned Behaviour is already a nice example of an integrated model, combining attitudes, norms and behavioural control as three drivers. Yet several more advanced architectures are available. These are helpful tools in guiding projects where multiple behavioural drivers and processes need to be combined.

3.03B: A simple agent based model (heuristics) - EXERCISE

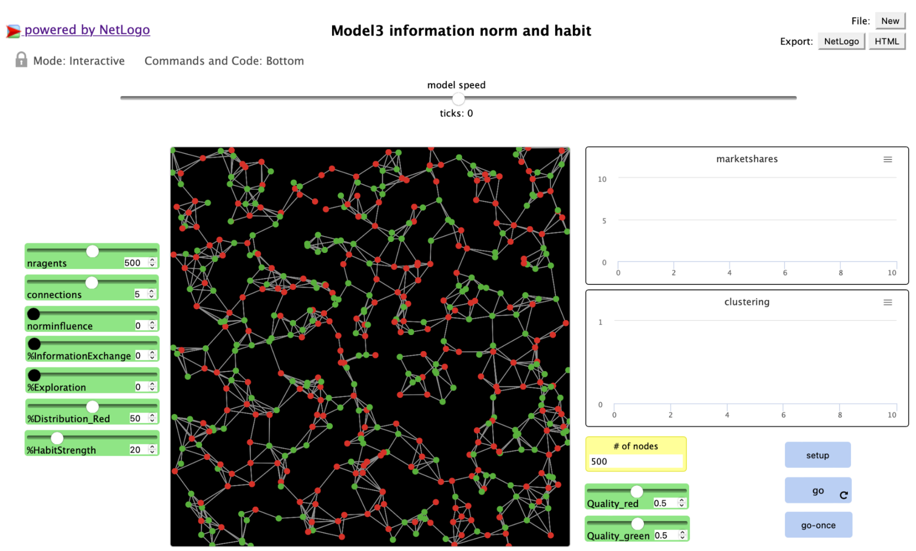
In the exercise on exploration and information exchange the agents immediately change towards the higher quality option when they find out about it, either by exploring for themselves, or by obtaining information from a connection. Adding normative influence added to the dynamics of change, making agents sometimes reluctant to adopt a better product because their connections don't use it, and sometimes speeding up a change of product consumption once a new norm is spreading in a society.

In this exercise we go a step further with the integration of behavioural processes in our agents by equipping them with a habitual force. This means that an agent may hang on to the old behaviour, despite being updated about the better quality of the alternative product, or despite the connections exerting a normative force to change.

The habit function has been implemented so that it takes more time for an agent to adjust its perceived utilities of a product. Hence repeated informational and/or normative influences are needed to change the agent's behaviour.

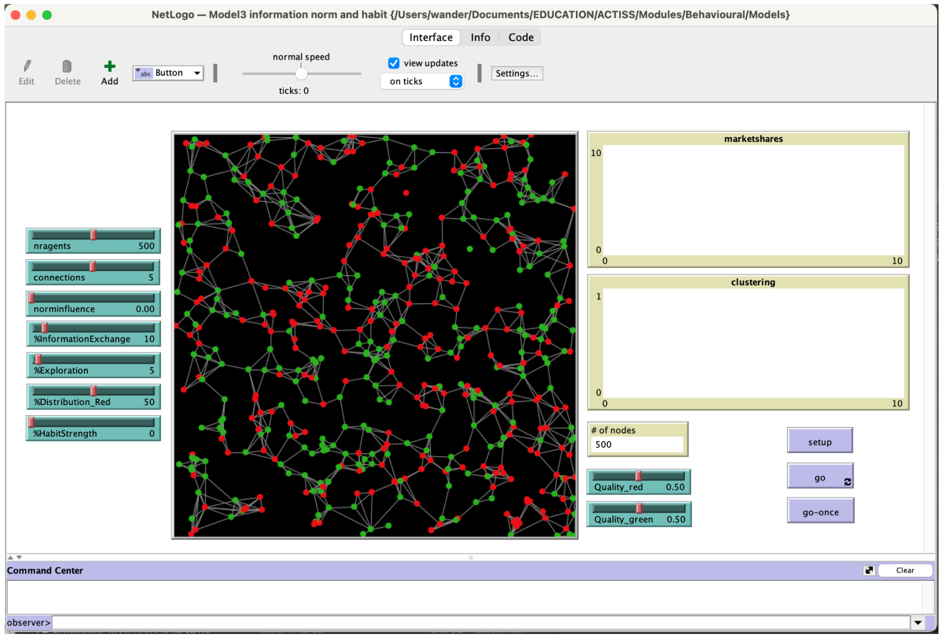
Setting up
You can run this exercise from the web by pressing the launch button at the bottom, or you can run it locally.

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 3 information norm and habit.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 agents that either use a red or a green product. Mind that these can also be interpreted as attitudes or opinions on an issue. In the sliders below you can adjust the quality of the products (could be the quality of an argument for an attitude or opinion). In the default setting the agents have 5 connections.

With **%Exploring** you set the chance that an agent will try another product.

With **%InformationExchange** you can set how often they ask other agents about their experiences.

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.

New is the slider **%habitstrenght,** which determines how fast an agent will adjust its perceived quality as a function of interactions. When habitstrength is 0, the agents have no memory at all, and they will quickly adjust their perception of the product quality if this is being changed, and change their behaviour. On the contrary, when habitstrenght is 100, it will take a long time for the agents to adjust their perceptions, and they will respond very slowly to changes in product qualities.

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.

You can also change the initial distribution of products using **%Distribution_Red** to experiment with different initial distributions of the products. Setting for example %DistributionRed at 10% allows you to experiment with the dynamics of the red product entering a market.

Experiment 1: exploration
Set %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. Now repeat this experiment for increasing levels of %HabitStrenght. What do you observe?

In the previous experiment you found out how a stronger habit affects the take-up of a product improvement. You can easily imagine that if you habitually buy a brand of tea, a price-cut or quality improvement of a competing product will go unnoticed. Maybe you don't even notice a price increase of your favourite brand. Only if your exploration is triggered by an advertisement in the shop, you may consider and try an alternative product.

Now imagine how it would be if you only get information from friends and family about changing products. In the following experiment 2 you can explore how that would work out for different habit strenghts.

Experiment 2: 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 increase the value of %HabitStrenght and observe what impact this has on the speed of change.

Now repeat this experiment several times, increasing the number of connections to 2, 3, 4...10 whilst systematically varying %HabitStrenght (e.g. compare a value of 10 with a value of 90).

If you compare the results of runs with a very low %HabitStrenght with runs with a high %HabitStrenght, what do you observe?

Besides inquiring and social information, obviously also norms have an influence on different sorts of habits. Adding this makes our model even more complicated and integrated. To get an impression on how this works, in the following experiment you can add norms as a factor.

Experiment 3: norms and habits
Repeat experiment 2, but now with a norm influence of 10 (you obviously can also explore other values).

3.03C How do habits affect our choice behaviour? - DISCUSSION

Bad habits. ©Picture by Manan Chhabra(Unsplash)

Whereas habits save on cognitive effort, and are very effective in saving time, they sometimes have a downside when the world is changing.

- What disadvantage of habitual behaviour do you see growing out of the previous experiments?
- Can you spot similar processes in the real world? Do you have nice (or less nice) examples?
- How can you stimulate people to change a bad habit? Think of different (combinations of) policies.
- Do norms concerning the social acceptance of (bad) habits play an important role? Can you think of practical examples?

Additional reading on habits:

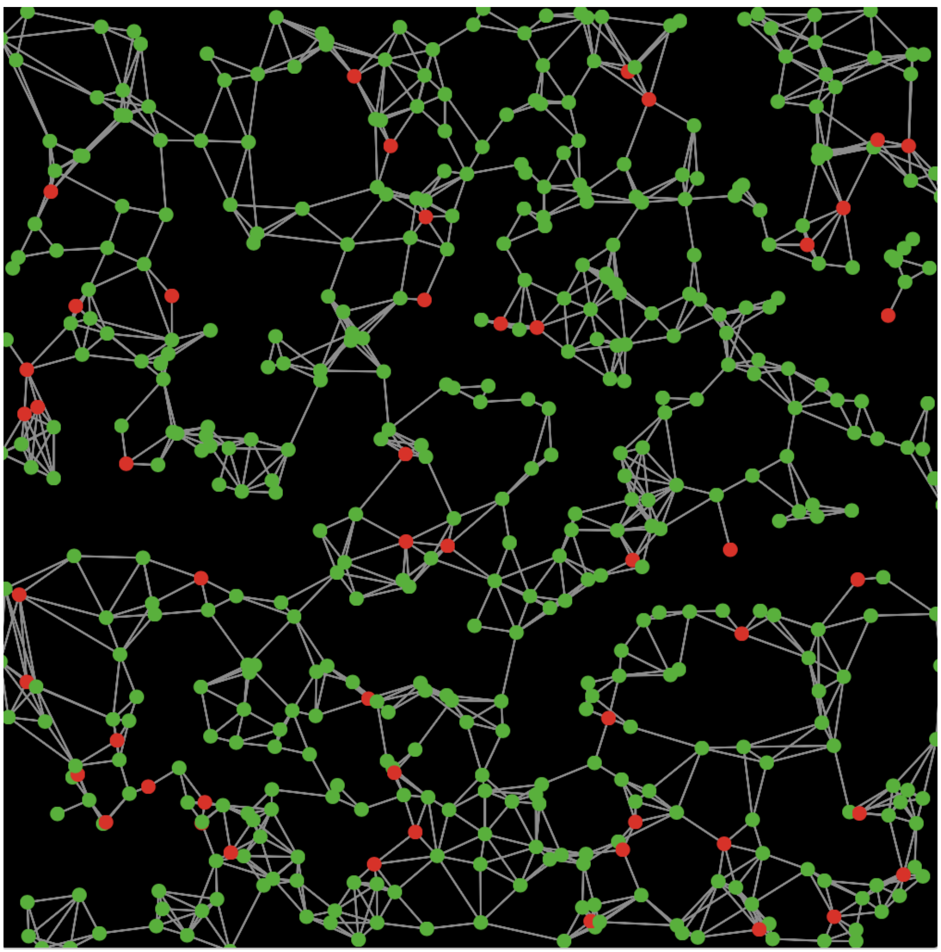
Jager, W. (2003) Breaking 'bad habits': a dynamical perspective on habit formation and change. in: L. Hendrickx, W. Jager, L. Steg, (Eds.) Human Decision Making and Environmental Perception.
Understanding and Assisting Human Decision Making in Real-life Settings. Liber Amicorum for Charles Vlek. Groningen: University of Groningen.

3.03D: A simple agent based model (heuristics) - EXERCISE

In the previous experiments we started with an equal number of red and green products or opinions. However, often new products or ideas enter a society, and they need to build up support or market-share to succeed. Even if they are of a superior quality, existing habits and norms may make it difficult for such innovations to become successful in diffusing through society.

Experiment 4: diffusion
This experiment uses the **model 3 information norm and habit.nlogo** from the previous experiment.

You can set %Distribution_Red at 10, so you start with a minority of 10% of the agents using or believing red as the following figure shows.



A 10% minority of agents using or believing red

In this situation the red product starts with a small market share, and it is of interest to explore the speed of the uptake of the red product in habitual and non-habitual markets (%HabitStrenght high and low).

For this, you can repeat the experiments 1, 2, and 3 but now from this minority position of red (%Distribution_Red = 10):

Experiment 4.1: exploration
Set %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. Now repeat this experiment for increasing levels of %HabitStrenght. What do you observe?

Experiment 4.2: 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 increase the value of %HabitStrenght and observe what impact this has on the speed of change.

Now repeat this experiment several times, increasing the number of connections to 2, 3, 4...10 whilst systematically varying %HabitStrenght (e.g. compare a value of 10 with a value of 90).

If you compare the results of runs with a very low %HabitStrenght with runs with a high %HabitStrenght, what do you observe?

Experiment 4.3: norms and habits
Repeat experiment 2, but now with a norminfluence of 10 (you obviously can also explore other values).

3.03E Further integration, the impact of habits on diffusion of innovations - DISCUSSION

Innovative technology ©Maximalfocus (Unsplash)

healthy practice ©Anupam Mahapatra (Unsplash)

Sometimes a new technology, or a new belief has benefits for society. Think of products that are cleaner or cheaper, or ideas and practices that contribute to a higher quality of life and wellbeing. However, if only a few people have adopted the new technology, belief or practice, its further diffusion may take a long time, or even fail altogether.

Can you explain how habits and norms play a role in the spreading of new beliefs, practices or technology in a society?

Do you think data collected from real cases can be used to make simulation models more realistic? What suggestions do you have to do so? As you experienced in the last exercises, adding additional behavioural processes to a model leads to an explosion of possible experiments you can run. If you want to model a specific behaviour, you may select a limited number of settings for a simulation model. Could you use empirical data, e.g. from a questionnaire or interview to decide on which model settings are realistic for a specific case? Please share your ideas.

3.04 HUMAT, an example of an integrative model - VIDEO

Storyboards texts:
3.04A
In several scientific projects, simulations with populations are being used to explore possible futures. Often, policies are tested to explore possible cause-effect scenarios

Depending on what societal issues are being studied, different models are being used to simulate human behaviour.

For example, when you study traffic in a city, the simulated people need to have different spatially arranged activities, and need for example health as a prerequisite for cycling.

3.04A shot in Noorderplantsoen
With a great group of people I collaborated in a project called SMARTEES aimed at simulating social innovation. We developed HUMAT as a framework for modelling the dynamics of social innovation.
Social innovation means that people organise themselves to make a change. For example, they may invest in a shared heat network, start a vegetable garden in a neighborhood, or organise themselves to make a park car-free. Yes, about 25 years ago this road was closed for car traffic after the local neighborhood started protesting about the unsafe situation for cyclists and children in the park. However, many car drivers enjoyed the freedom to drive through the park with their car to go shopping, go to their job or visit friends. A referendum was called to decide on the plan to close the park for cars, and in the run-up to this referendum much discussion took place. The referendum was won by 50.9 percent of the people voting for a closure of the park. A close call, reminding me of the Brexit referendum, or American presidential elections. To model this process, we needed to integrate ideas about networks from sociology, ideas on interaction and persuasion from social psychology, and ideas on attitude change and cognitive dissonance from cognitive psychology.

3.04B
In the past the main road in the park in Groningen, the Netherlands, was intensively used by cars, as these pictures show (pictures). You can imagine the people cycling through the park and the parents in the neighbourhood had concerns about their safety and the safety of their children


A referendum took place in 1994 on closing this park for car traffic. Because of the many discussions, we decided this was an interesting case to explore with our simulation model.

We developed the HUMAT model for simulating processes of social innovation. The simulated people have different interests in the park, and these are related to where they live, their age, economic activity and education. Just imagine a mother whose child is playing in the park, a student that is commuting there by bike, and a pensioner driving his car here to visit friends.

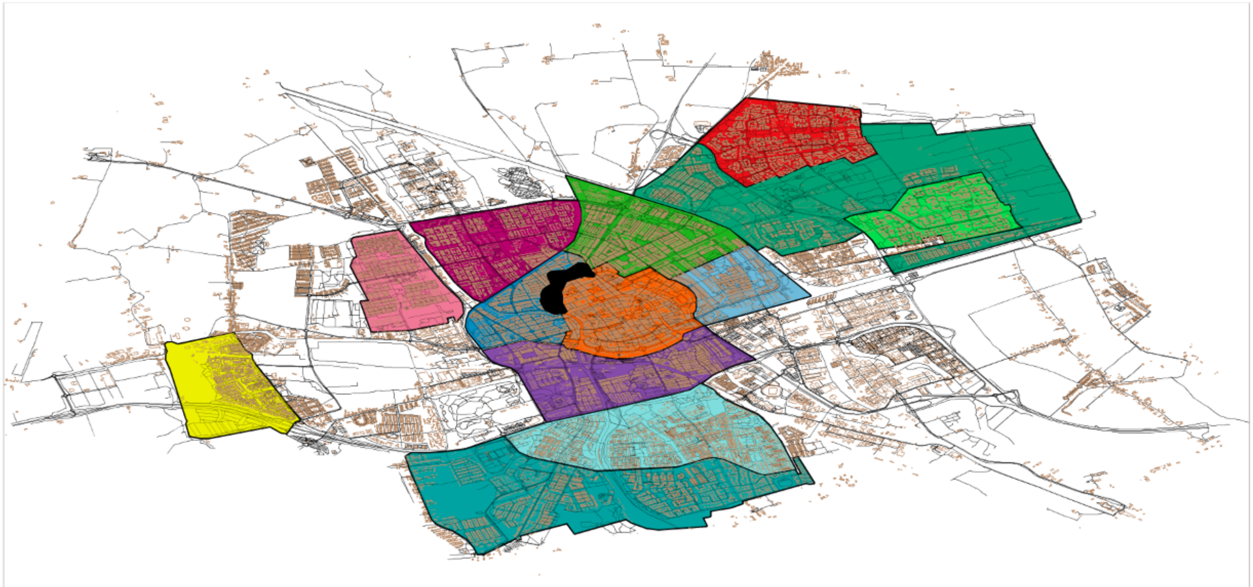
The simulated people discuss the plan to close the park for cars with family members, friends and colleagues. The persuasive process is especially relevant to model here. When does a person speak up, and who is listening? So, we built a model of the city of Groningen in the Netherlands.

voice over simulation model
Here you see a map of the city of Groningen in the Netherlands. The park can be seen as the black banana-shape in the middle. The simulated people, more than seventeen-thousand in this model, may vote if the park should close for cars or not. Agents favouring a closure are green. As you see, in neighborhoods close to the park a majority is for closure. The red agents support the opening of the park for cars. As you can see, these are mainly living in the neighborhoods further away from the park. Now we launch a campaign stressing the benefits of closing the park for cars. As you can see, a majority of simulated citizens living further away from the park also start supporting a closure. Not only is this because some people change their opinions, but also because those that did change their opinion, may also influence at a later stage their friends, colleagues and family members. These social effects are typical for social innovation projects.

3.04C
With such a model many policy scenarios can be tested, for example the effect of organising neighborhood or town-hall meetings on the spreading of ideas, but also the impact of opinion leaders in the media.
This example shows that Agent Based Models integrating theoretical ideas can be useful in constructing artificial populations. And you can imagine the many experiments that are possible, both to develop our theoretical understanding of behavioural dynamics, as well as supporting processes of societal change aiming at improving society. It can be expected that there will be an increase in the development and use of such integrated models, and they will contribute not only to the further integration of the social sciences, but also to connect social science to for example ecological sciences, a topic that is being addressed in our course called “Common Problems with Common Goods: The Mechanisms behind Sharing and Cooperating?”

3.04D shot in Noorderplantsoen
When people in a community want to make a change, municipalities could support them by initiating a simulation project. In such participative modelling projects people can explore different future scenarios, and discuss the possible effects and fairness of policies. It may become clear what risks exist concerning polarisations, and it may help a dialogue where the interests of different groups of people are considered. In this way we hope that in the future local democracies will get stronger, avoiding opinion polariations that can paralyse a community.

3.05 What next? - ARTICLE



A map of simulated Groningen, where 14.165 agents interact

The HUMAT integrated architecture has been developed within the EU Horizon2020 SMARTEES project, and models successful cases of social innovations implemented in European cities and islands. Cases address for example refurbishment projects of rental homes, the banning of transit car traffic from neighborhoods and parks (as discussed in the previous video), and heat network projects in cities.

HUMAT has been developed as an integrated framework combining a number of critical behavioural drivers and processes, and guides the use of data, both qualitative and quantitative, in setting up a simulation model to explore the social dynamics for specific cases.

Here we provide a very brief overview of the behavioural drivers and processes that are included in HUMAT agents. The agents are motivated by three groups of needs, respectively

(1) **subsistence**, i.e. immediate consequences of actions in terms of safety, comfort and finance,
(2) **social**, i.e. group norms and their importance for social identity, and
(3) **personal**, i.e. religious, ecological, economical and (sub)cultural values.

Each agent is also equipped with memory storing past experiences. An agent can ask other agents in their network(s) after their experiences (inquiring). But an agent can also try to persuade other agents to change opinion or behaviour. Especially when friends have deviant opinions, cognitive dissonance may be experienced, which can be resolved by convincing the other, or complying to the other. Think for example of a vegan person, who is trying to convince his or her friends to become vegan too.

The networks can be made dynamic, where old links disappear and new ones emerge, for example breaking a link with another agent with persistent opposing views on important matters.

HUMAT thus provides a framework that allows for modelling the complex social dynamics that are responsible for many societal issues.

For an example of applications you can visit this detailed deliverable of the SMARTEES project on local social innovation.

3.05A: What societal issues can be addressed? - DISCUSSION

Society ©Storyblocks

In the previous step you have been familiarised with an integrated model to simulate community behaviour.

For what type of societal issues do you think such models can be used?

What types of cognitive processes and behaviours do you think are interesting to implement in specific models of certain issues?

Who should use these models, and for what purposes?

Do you have ideas on needs, emotions or other elements that could be modelled?

Could it be interesting to let the community being simulated to support the model of their own community? Could this support a dialogue in a community? How could community issues or projects benefit from such “participatory modelling”.

Having such models to “control” a population can easily cause distrust in the population being modelled. It is easy to imagine an evil villain manipulating a population to do what he wants people to do. Including people in the model development (participatory modelling) is often used to improve the model and get support from the community. How can you include the population in modelling exercises? Do you expect this could support local democratic processes?

3.07 How realistic should a model be - VIDEO

In this video, Wander Jager discusses the level of realism that is needed for a model.

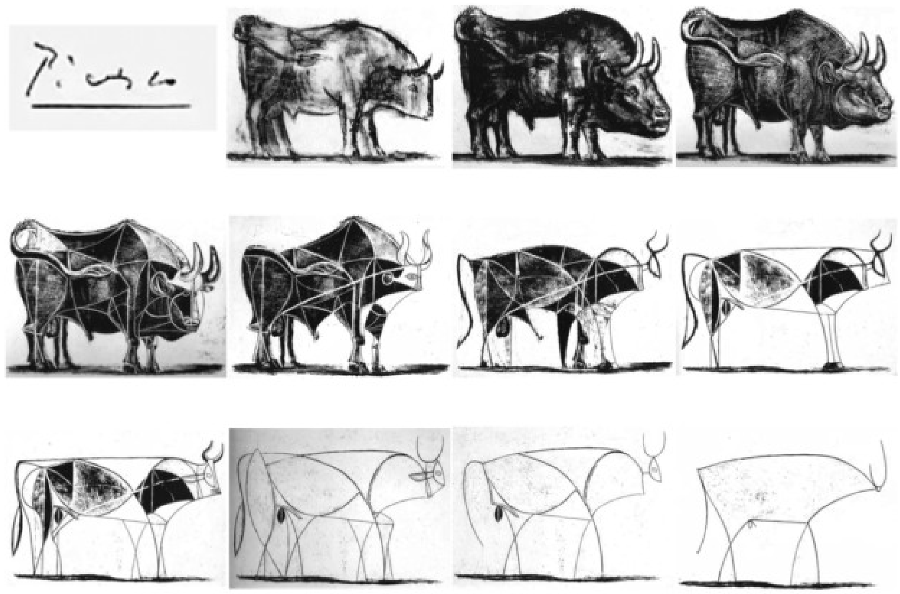
Storyboard text

3.07Asitting with a lego model
Models are models...a simplification of reality. In developing models, we often think that being more realistic is better. But think of a paper map, for a mountain hike detail can be critically important, but if you navigate the highways a real simple sketch of the main roads would be more easy to use.

3.07
The same applies to the modelling of humans and their societies. It all depends on the use of the model how much detail is needed. Do you work on a disaster evacuation model? Not much need for an elaborated social network model. But spatial cognition is definitely something your agents need. Do you want to model online opinion dynamics? You definitely need to know about theories of informational processing and biases.

3.07B When developing models, we therefore should remember the famous quote of Albert Einstein: A theory should be as simple as possible, but not simpler than that.

3.08 KISS and EROS: On realism versus simplicity of models - ARTICLE



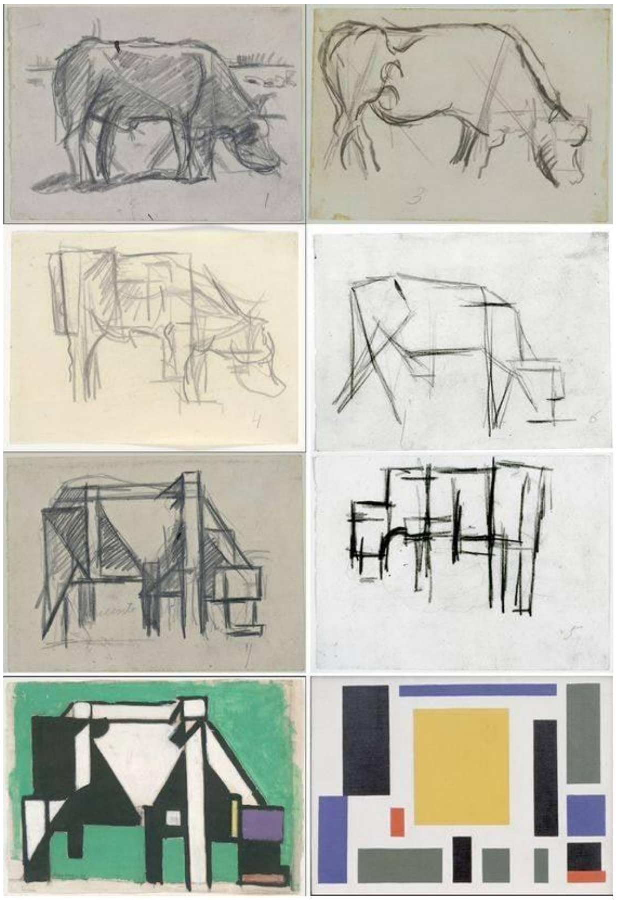
Pablo Picasso, different levels of detail in modelling “The Bull”, lithographs, 1945 link

Balancing simplicity and realism in a model is always a challenge. Albert Einstein’s quote “a theory should be as simple as possible, but not simpler than that” certainly applies to models. But how simple is simple enough?

One perspective in the social simulation community focusses at “Keeping It Simpel and Stupid” (KISS). This position advocates that a model should be as simple as possible, trying to replicate a real phenomenon with a minimal model. The principle of Occam’s razor applies here: cut everything away that is not strictly needed to explain a phenomenon.

The other perspective takes the principle of “Enhancing Realism Of Simulation” (EROS). Here it is advocated that a model should capture as well as possible the theoretical mechanisms and empirical data of a phenomenon.

How much detail is needed in a case model (balancing KISS with EROS) to make it useful is a critical question to address. Mind here the example of the map in the video. While in principle it is possible to represent every unique person as a simulated agent in a community, and make this person as realistic as possible with regard to physical, economical and cognitive characteristics, this does not seem to be necessary to capture the essential social dynamics of a case. Just like with the example of the map, a more simplified representation may be more effective for the purpose of the model. But what are the “essential social dynamics” is the successive question to answer. And what is essential depends on the use and user of the model.


Theo van Doesburg Compositions (The Cow) 1917 - 1918

Van Doesburg, in his search for the essence of the concept of a cow, systematically removed all shapes and lines that were not crucial for recognising the cow. To explain to a tourist in France what “la vache” means, a very sketchy model of a cow suffices, but a veterinarian would need a much more detailed model of a cow to be capable of preparing a medical procedure.

The Van Doesburg drawing provides a metaphorical illustration of the process of defining essential elements for a model. The most elaborate picture is still a picture, not the cow itself. Equally, our data, however detailed they may be, are data about the case, not the case itself.

In the SMARTEES project we developed very detailed models, such as the model of the referendum on the closure of the park for cars. Many data on socio economic characteristics and preferences and perceptions have been collected to construct a representative simulation model. Several of such detailed models have been developed for different types of cases. These models can serve as an inspiration for similar cases that expect to deal with similar social dynamics.

Ultimately we think that constructing case models together with the people that are being modelled in a participatory way will help local communities to reflect on the social dynamics that may happen in their community and affect their future. Anticipating possible conflicts may help thinking about strategies to mitigate problems before they spin out of control.

3.09: What next? - ARTICLE

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

An interesting question is if social simulation models are a new kind of theories? Especially when you are studying social sciences, or are planning to do so, it might be good to reflect on this.

To begin with, social simulation models do provide causal connections, how simple they may be, between different theoretical mechanisms and drivers of behaviour. Combining them in a computational framework adds a dynamical dimension of process-growth to these (simplified) theories, thus producing "generative social science" as stated by Epstein (2006).

The question is if the simulated social dynamics are explanatory for real world phenomena. How should empirical data be used to test the explanatory power of the simulated dynamics?

The crux of the answer resides in the complexity inherent to social systems, which implies that social dynamics can be in a state of turbulence. As Lorenz (1963) demonstrated for meteorology, small causes may have large effects in such systems (see the introductory module on the fundamentals of complexity). This certainly applies to social systems, as revolutions, disruptive innovations, hypes and fashions can be strongly influenced by a few or sometimes even a single person.

Whereas social systems are usually in a more stable state, where behaviour and the impact of policies is predictable using statistical analysis (i.e. marketing research), it is precisely at moments of turbulence where the future may go in different directions, and small events may cause large cascading effects.

This means that replicating historical data, a common way of validating models as being a theory, is not justified because the data could have been really different if they originate from a turbulent behaving social system.

As a consequence, the question if simulation models can be considered to be a theory raises important philosophy of science questions.

From a practical perspective we can state that if a simulation model demonstrates to be capable of mimicking behaviour of a variety of people in different cases in a theoretically and empirical convincing way, we may start thinking about a solid dynamical theory of behaviour.

In that sense we expect that simulation models of social dynamics contribute to the further development of the relatively young social sciences, bringing in the insights from complexity theory that are already embraced in the natural sciences. In that sense we expect a great and challenging future of computational social science because of its firm causality, the capacity to integrate different theories, and the possibility to systematically study how interventions affect large scale and long term social dynamics.

For computational social science to prove its value as a theory we can conclude with the famous statements of the social psychologist Kurt Lewin (1890 – 1947)": "Nothing is as practical as a good theory," and "the best way to understand something is to try to change it."

Reference:
Epstein, J.M. (2006). *Generative Social Science*. Princeton University Press.

3.10 Wrap up - VIDEO

3.10 sitting with a lego model/puppets

The implementation of theories in agent based models is a challenge, but increasingly we succeed in creating more realistic behaviour with our models. Compared with the early agent based models, and the assumptions of individually optimising people, current models are a major step forwards.

Interestingly, we now see that different social sciences are connecting in these models. We have the level of cognition, where learning and dissonances take place, the level of interaction, where persuasion and exchange play a role, and the level of networks, where connections are made and broken.

This all is developing into the "generative social science" as Joshua Epstein calls it, a new level of social science that is capable of growing social phenomena.

The complexity of many societal challenges mean that we should be really modest about our capacity to predict the future. You know, human social systems are more complex than the weather, and weather forecasts become almost impossible beyond 10 days in the future.

However, the more we understand the dynamics of our own behaviour, using such models, the better we are able to identify different possible future scenarios, and think of policies that contribute to a better future.

3.11 What next? - ARTICLE

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

You have finished the course. Thank you for participating!

We hope that at this stage you are able to:

- Discuss the problem of conflict between individual and collective rationality using examples.
- Apply the basic concepts from game theory to explain some of the mechanisms leading to the ecological crisis and its potential solutions.
- Solve simple games using basic game theoretical tools.
- Experiment with a simple agent-based model by changing the properties of the existing components.
- Identify the opportunities computational models and simulations offer to help study complicated social processes.
- Evaluate possible solutions to problems related to public goods with the help of computational modelling.

Learn more

Learn more
This course is a part of an educational initiative **Action for Computational Thinking in Social Sciences**. This project is carried out by a strategic partnership formed by enthusiasts of modelling and simulations and opening-up education and includes partners from Warsaw, Groningen and Berlin. It was co-funded by Erasmus+.

If you are interested in exploring computational social sciences further (and we sincerely hope you do), we encourage you to:

- visit the project website and learn more about the initiative;
- try out our other courses, including People, Networks and Neighbours: Understanding Social Dynamics, Understanding Human Behaviour and about social network analysis.

If you are a student, we also encourage you to look for computational social sciences courses, both within your educational institution and online (try looking for topics such as: computational models, computational social science, modelling and simulations, agent-based models or social network analysis).

If you are a teacher or academic teacher, we encourage you to use the materials from the course (and other ACTISS courses) in your teaching. You will be able to download the materials and find YouTube videos and models from the courses here. We'll be very happy if you do!

More to explore

If you are looking to read more about social computation, we recommend having a look at the following resources:

The Journal of Artificial Societies and Social Simulation (JASSS) is the leading journal in the field of social computation. It is an open-source on-line journal giving you access to the most recent applications of social computational models.

CoMSES Net is an international network of researchers, educators and professionals with the common goal of improving the way we develop, share, and use computational modeling in the social and ecological sciences.

Studying at University of Groningen or University College Groningen

University College Groningen is a Faculty of the University of Groningen, one of the world's top 100 universities. We offer a Bachelor in Liberal Arts and Sciences, which will provide students an academic degree with a genuinely interdisciplinary outlook, freedom of choice and a collaborative and guided approach to learning in a stimulating and globally challenging environment.

Our Liberal Arts and Sciences programme offers students the opportunity to study a broad range of subjects whilst developing specialist knowledge in their major discipline (Humanities, Sciences, Social Sciences). Throughout the degree students will work in interdisciplinary teams on a series of projects that take them outside of the classroom. This will enable students to learn how to apply a creative approach in finding solutions for complex global challenges.

Studying at University of Warsaw

University of Warsaw is the leading research university and the largest higher education institution in Poland, with a comprehensive portfolio of research and teaching activities. Faculty of Sociology offers BA and MA level studies in Sociology and has recently launched a new MA programme of Digital Sociology.

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