Simulating the Spread of Vegetarianism with NetLogo

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EXPLANATION OF THE SIMULATION

I offer an agent-based simulation with NetLogo that aims to give an intuition for the effect of a higher meat price and the supply of meat substitutes on the consumption behaviour of individuals. For this, I modelled the meat and meat-substitute market and based the simulation of sustainable behaviour partially on the paper and project 'Cultural Evolution of Sustainable Behaviors: Pro-environmental Tipping Points in an Agent-Based Model' by Roope Oskari Kaaronen and Nikita Strelkovskii (2020). In the following, I provide a detailed description of the simulation. The code for the simulation can be found in the GitHub repository.

CONTENT

1 General Set-Up

The model consists of agents split into vegetarians and meat-eaters. There are 100 agents in the simulation to make calculations and evaluation easier. A supermarket supplies the agents with meat and substitutes represented by red (meat) and blue (substitute) patches on the right side of the Netlogo grid. There are 500 product patches available to ensure that the supermarket supplies the agents with at least one of the products in all cases. Every three days, the supermarket restocks its supply. Roughly 10% of the agents are vegetarians, which corresponds to the proportion of vegetarians in the German population.[1] Vegetarian agents are coloured green. Initially, all agents are on the left side of the grid. Through the 'network'-switch, it is possible to choose if they are connected and can communicate with each other or not. The set-up of the supermarket and the network can be modified through several sliders, which I will explain in more detail below.

The button 'set up' sets up the simulation according to the options chosen through changes of parameters by using the sliders. The button 'go' starts one run of the simulation, while the button 'keepgoing' keeps the simulation running until pressed again.

In short, the simulation runs as follows: The agents base their consumption decision on their personal preferences determined by their personal states and influenced by price and supply. After they decide what to buy, they move to a patch of the product and then back to the left side of the grid. The patch they sat on turns black to show that this portion of the product is not available anymore. If the network is enabled, agents talk to each other afterwards. Through talking, the agents learn about the attitudes of their social contacts and their own attitude changes. In addition to that, they also learn through the consumption of the products, which influences their attitude as well. Every three days, the supermarket restocks its shelves and adapts the supply to the demand.

In the following paragraphs, I will describe the different stages of a simulation run in more detail. I will start with the agents' decision-making process and then explain the 'buy' procedure, the network, the learning procedures and the refill of the supermarket.

2 Decision-Making-Process

The agents decide based on their personal states. Those personal states define if agents are vegetarian or not and how they behave.

Personal States

Each agent has traits that correspond to personal states in the real world. Following the modelling choices for personal states of Kaaronen & Strelkovskii,[2] two initial states are assigned to each agent (two turtles-own variables, ' pro-veggie' and 'non-veggie'). Both variables are probabilities of consuming substitutes or meat. The basis of this probabilities is a normal distribution around the mean of 0.7 or 0.3, depending on the group membership of the agent and a standard deviation of 0.15. To make the simulation

[1] DIEMAN, STEFANIE, JUNGE, SVEA & LÖHR, JULIA: Doppelt so viele Vegetarier. Ernährungsreport, in: Frankfurter Allgemeine Zeitung (19.05.2021).

[2] KAARONEN, ROOPE O. & STRELKOVSKII, NIKITA: Cultural Evolution of Sustainable Behaviors. Pro-environmental Tipping Points in an Agent-Based Model., in: One Earth 2 (2020), p. 85 – 97.

more realistic, an upper and a lower bound are assigned to each agent. In reality, an individual rarely has entirely consistent behaviour. To represent that, it is impossible to reach 0 or 1 for the probabilities' pro-veggie' and 'non-veggie'. Both bounds are based on a normal distribution with a mean of 0.8 and 0.2 and a standard deviation of 0.05. Kaaronen & Strelkovskii explain this modelling assumption as follows: 'This allows for some agents to adopt more extreme habits than others, which is in line with empirical observations; for instance, some people might be more prone to adopting strict vegan habits than others who adopt, at most, part-time vegetarian or flexitarian eating habits.'[3]

Pro-Veggie and Non-Veggie as Probabilities

The turtle-own variables' pro-veggie' and 'non-veggie' function as probabilities for pro- or non-vegetarian behaviour. If 'pro-veggie' is larger than 'non-veggie', the agent is vegetarian. In this case, the agent wants to buy a portion of the substitute with a probability of 'pro-veggie'. If 'non-veggie' is larger than 'pro-veggie', the agent is a meat-eater and wants to buy meat with the probability of 'non-veggie'.

The Influence of Price and Supply on the Decision-Making-Process

After they decide what they want to buy, the agents compare the prices of substitutes and meat. They are willing to pay 1.5 times the price of the unwanted product to get the product they want. If the wanted product is more expensive than 1.5 times the price of the unwanted product, they will try to buy the unwanted product.

If there is no patch of the product, they try to buy available, the agents will buy the other available product.

3 Buying the Product

The agents move to a patch of the product they choose. After every agent moved to a product patch, the agents leave the supermarket and the patches on which the agents were, turn black to show that the product was sold.

4 Network

In the NetLogo simulation, social interactions between agents are possible through a simple Erdős–Rényi network as offered by Kaaronen & Strelkovskii.[4] The average of social contacts (links) per agent can be specified through a slider on the interface of the simulation. The create-network procedure asks a random agent to create a link with another agent and repeats this so often that the agents have on average as many links as specified by the slider.

5 Learning through Buying (Asocial Learning) and Learning through Talking (Social Learning)

The variables 'pro-veggie' and 'non-veggie' change through two mechanisms: asocial-learning and a social-learning mechanism. To model this, I followed the modulation of Kaaronen & Stelkovskii again.[5] Firstly, if an agent buys meat, the 'non-veggie' variable increases by the value of 'asocial-learning', determined by a slider and 'pro-veggie'

[3] KAARONEN & STRELKOVSKII: Evolution (2020), p. 95.
[4] Ibid.
[5] Ibid.

decreases by the same value. If an agent buys substitutes, the same happens the other way around. This procedure can lead to a decrease or increase in the share of vegetarians.

After the agents moved back out of the supermarket, they talk to each other via the network. If they are vegetarian, they influence the 'pro-veggie' variable of the agents they are linked with increases by the value of the 'social-learning slider and 'non-veggie' decreases by the same value. If an agent is a meat-eater, the same happens the other way around.

6 Supermarket

After three days (three ticks), the supermarket restocks its shelves. The supermarket compares the amount of red and blue patches to find which product is more in demand. The product with the higher demand is restocked with a larger share than before.

REFERENCES

DIEMAN, STEFANIE, JUNGE, SVEA & LÖHR, JULIA: Doppelt so viele Vegetarier. Ernährungsreport., in: Frankfurter Allgemeine Zeitung (19.05.2021); *https://www.faz.net/aktuell/wirtschaft/ernaehrungsreport-doppelt-so-viele-vegetarier-17348877.html* (10.09.2021).

KAARONEN, ROOPE O. & STRELKOVSKII, NIKITA: Cultural Evolution of Sustainable Behaviors. Pro-environmental Tipping Points in an Agent-Based Model., in: One Earth 2 (2020), p. 85 – 97.