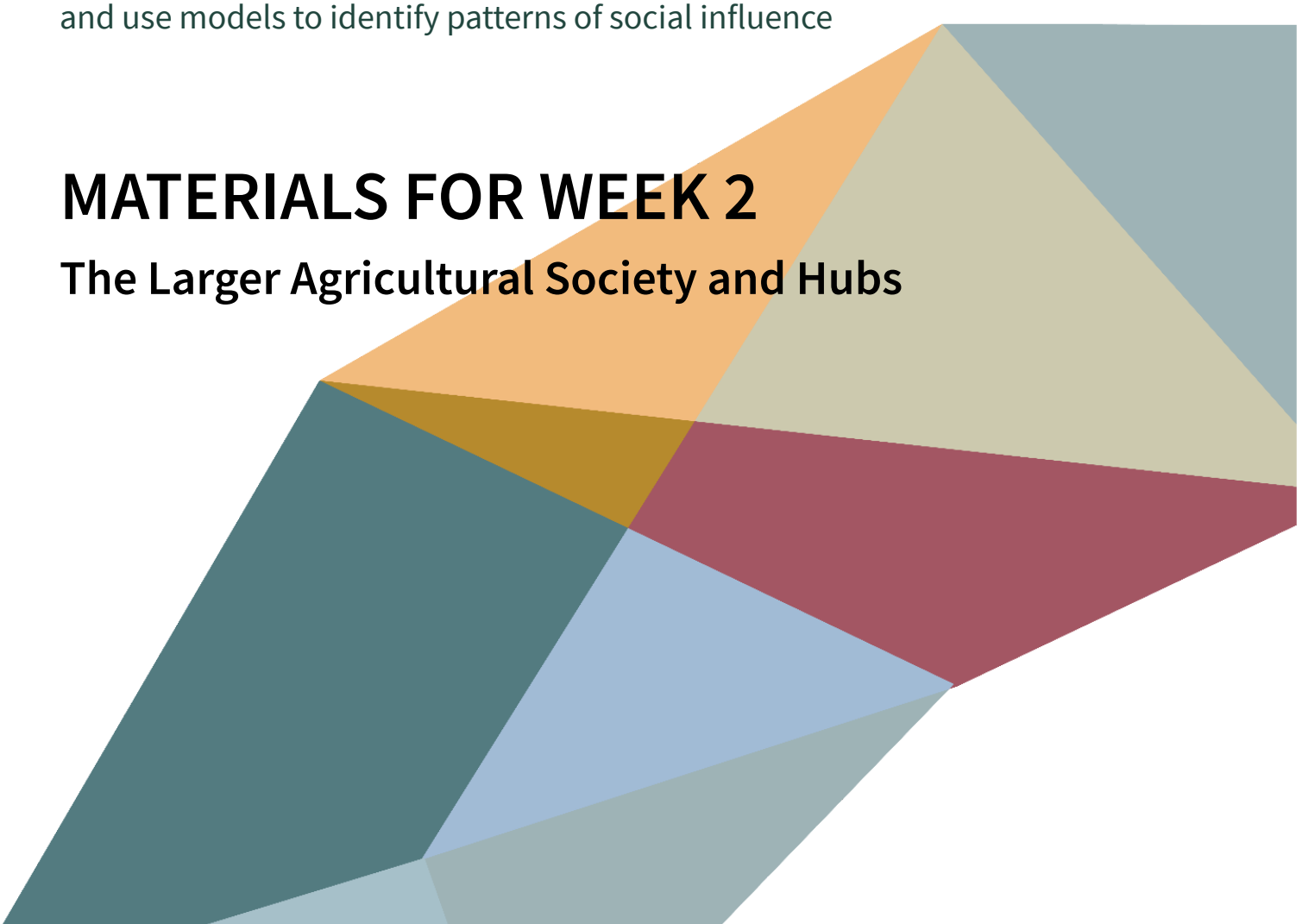
ACTISS
ACTION FOR COMPUTATIONAL THINKING
IN SOCIAL SCIENCES

INTRODUCTORY COURSE

Social Network Analysis: The Networks Connecting People

Explore the structure and dynamics of different types of social networks and use models to identify patterns of social influence



MATERIALS FOR WEEK 2

The Larger Agricultural Society and Hubs

INTRODUCTORY COURSE

Social Network Analysis: The Networks Connecting People

MATERIALS FOR WEEK 2

The Larger Agricultural Society and Hubs

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OVERVIEW OF THIS WEEK'S MATERIALS

This week deals with the role of "hubs" or "superspreaders" in social networks, and will introduce you to the sharing of information and normative influences that are important in the spreading of e.g. products, ideas and opinions in social networks.

Keywords:

STRUCTURE OF THIS WEEK'S MATERIALS

How many people do we know in a network?
In this week we will explore the role of people having many contacts, the so-called hubs or superspreaders' have on network dynamics.

STEPS:

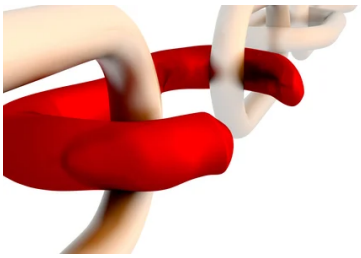
Welcome to Week 2 – ARTICLE
Network distribution and hubs – VIDEO (02:36)

How popularity grows
In this activity we discuss preferential attachment and hubs.

STEPS:

Agriculture, writing, hubs and trade – ARTICLE
Network distribution and hubs – VIDEO (02:13)
Virus in the tribe with hubs – ARTICLE
Virus in the tribe with connectivity of hubs - EXERCISE
Questions about hubs – QUIZ
Preferential attachment in your life – DISCUSSION

How do hubs function as superspreaders in society?
In this activity we will reflect on the role of so-called weak links, as opposed to hubs



STEPS:

Weak links and preferential attachment – ARTICLE
Hubs and weak links - DISCUSSION
Questions about network properties and hubs – QUIZ
How much interaction did you have today through which channels? - DISCUSSION

More than viruses: sharing information
In this activity we address the spreading of information through a network. Because these influences require more conscious processing than the spreading of a virus, the network dynamics are different.

STEPS:

Exchange of information - VIDEO (04:01)

The impact of social norms in networks - ARTICLE

Informative influence in the tribe - EXERCISE

Adding informational exchange into the tribe - EXERCISE

When information is not being shared - DISCUSSION

Obeying the norm
In this activity we address the spreading of and norms through a network. Because these influences require more conscious processing than the spreading of a virus, the network dynamics are different.

STEPS:

Normative influence in the tribe - EXERCISE

A normative lock in - EXERCISE

Diffusion curves - EXERCISE

Social norms and tipping points in networks - ARTICLE

Lock-ins and norms - DISCUSSION

Questions about the impact of norms in networks - QUIZ

Wrapping Up Week 2

We look back at the second week and ahead to what is to come in Week 3.

STEPS:

Wrapping up Week 2 - ARTICLE

EDUCATIONAL MATERIALS

1. Welcome to Week 2 – ARTICLE

Last week we started with the clustered network of the tribe, where basically everybody interacts with everybody. You have experimented with a first simulation model, experiencing the concepts of clustering and path-length in networks.

When societies grew in times of the agricultural revolution, leaders emerged that had an influence on many other people. In terms of networks, we call these hubs, and in this week of the course, we will explore their role. You will experiment with a simulation model where hubs can be created, and you can explore for yourself how they affect the spread of a virus.

We will also explore other influences in social networks, in particular, the influence of norms. Whereas a virus will spread without you needing to think about it, buying a product or accepting an opinion requires a more deliberate choice. Just imagine that you are considering buying a new pair of shoes for running or hiking. You would most likely consult your friends about their opinions on the quality of certain brands of shoes, and if they feel that they are good value for the money.

You can also observe what brand of shoes are worn by people around you, and it is imaginable that you know what brand of shoes are worn by your favourite celebrity. Companies like Nike invest quite a bit in endorsing celebrities to wear their apparel and make their brand visible.

Here we touch upon two different types of influence running through networks: information and norms. Information relates to product characteristics, ideas, expectations and opinions. Norms, however, focus on how often you observe others using a certain brand or having a particular opinion.

This week we will explore two basic elements of social networks: the role of these influencers, or in network terminology, hubs, and the role of norms in the spreading of products, ideas and opinions over a network.

2. Network distributions and hubs - VIDEO

In this video Wander Jager explains that with the rise of agricultural society, cities emerged and the total size of the networks became larger than the original small tribes humans were living in. An important observation is that these larger societies also gave rise to people having many contacts, such as queens and priests. These so-called hubs can have a strong impact on network dynamics.

3. Agriculture, writing, hubs and trade – ARTICLE

With the development of agriculture, it became possible to produce food in a more efficient way. As a result, tribes could grow, and specialisation became possible. Over time, larger societies developed, and the first cities grew. Agriculture also came with new ownership rights, requiring an administration that used written language and math.

Administration was a first purpose of writing

With larger groups of people, an increase in specialisation became possible, and hence we see the emergence of toolmakers, builders, soldiers, administrators and clergy, to name a few. This process of growth and specialisation caused societies to become more complex in their structure. Power became more institutionalised in both material and spiritual dimensions, and kings, nobility and priests were people having a disproportionate influence on and power over the common people. These powerful people functioned as hubs in the societal network, informing and commanding a lot of people.

Not only did the size of societies expand, as in the early cities such as Mesopotamia, but also travel, trade and war became more intensive and organised. Many inventions, such as the wheel, roads, sailing & navigation, building bridges and the like fostered exchanges of goods and ideas between people at larger distances. Grain, timber, furs, salt, ideas, writing, gunpowder were among the goods and inventions that travelled through networks, just as diseases like the plague, measles and smallpox.

4. Network distributions and hubs – VIDEO

In this video Wander Jager discusses the concept of hubs. It is being explained what role hubs play in a network, and why we like to connect with the "popular hubs". This process is called "preferential attachment". We will also introduce you to the next model exercise.

5. Virus in the tribe with hubs – EXERCISE

In this exercise, you will use the same model of a networked tribe we used for the exercise step Virus in the Tribe in Week 1. The only difference is that now we have hubs in our tribe, representing the nodes in the tribe that have much more links than the average tribe member.

Often you hear people speaking about superspreaders when describing people that have infected many other people. Usually, these are people with many contacts, and in terms of network theory, we call them hubs. Especially in the 1980s, when the HIV virus was spreading, attention was focussing on the role of sexually very promiscuous people that played an important role in the spreading of the virus. More information on this can be found **here**.

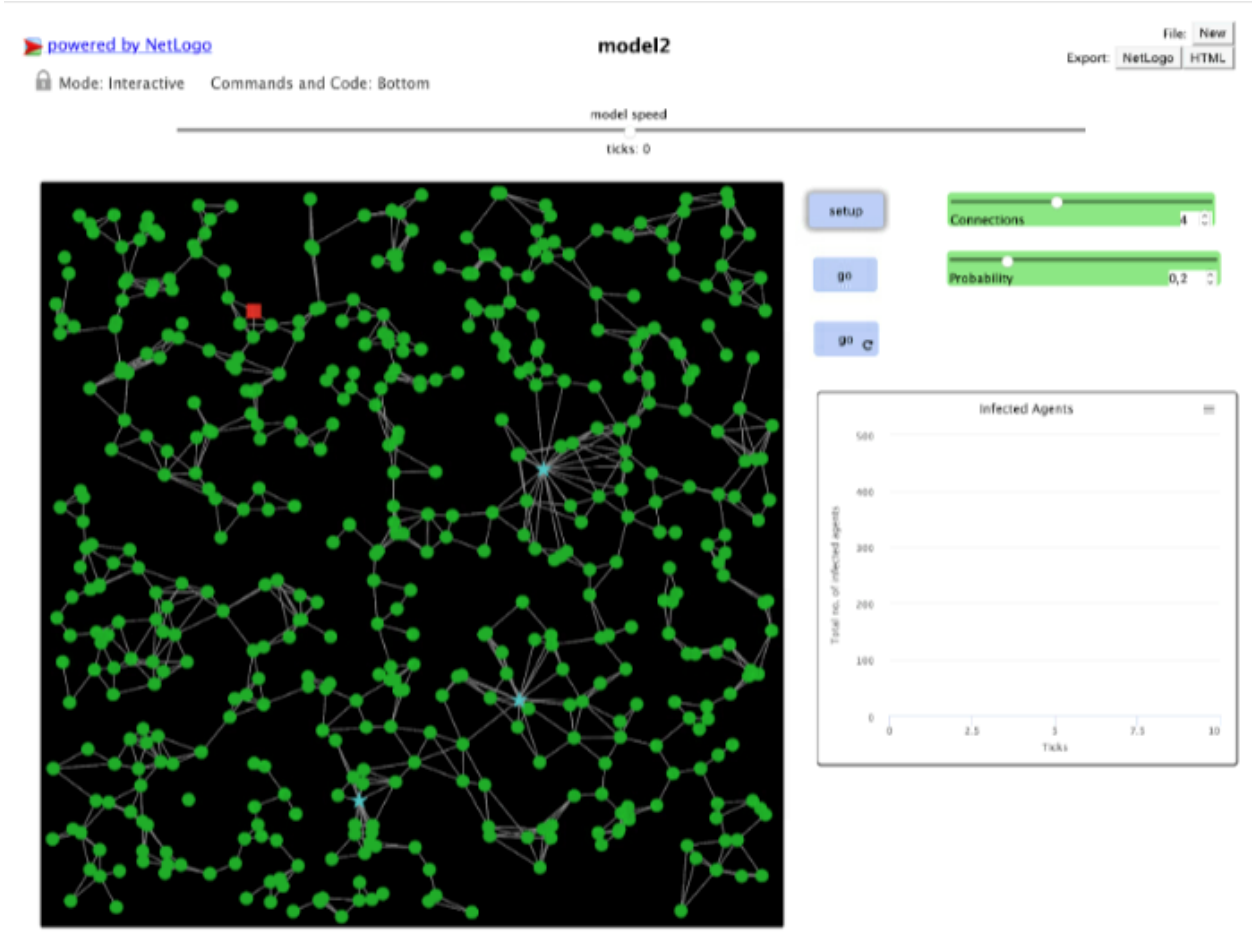
Whereas you often hear the term of superspreader in the context of viruses, the term is also useful to express people that have a lot of contacts and play a pivotal role in the spreading of opinions and information.

In our exercise, we will explore the role of a hub or these so-called superspreaders on the speed and degree in which a virus spreads over a network.

Setting up

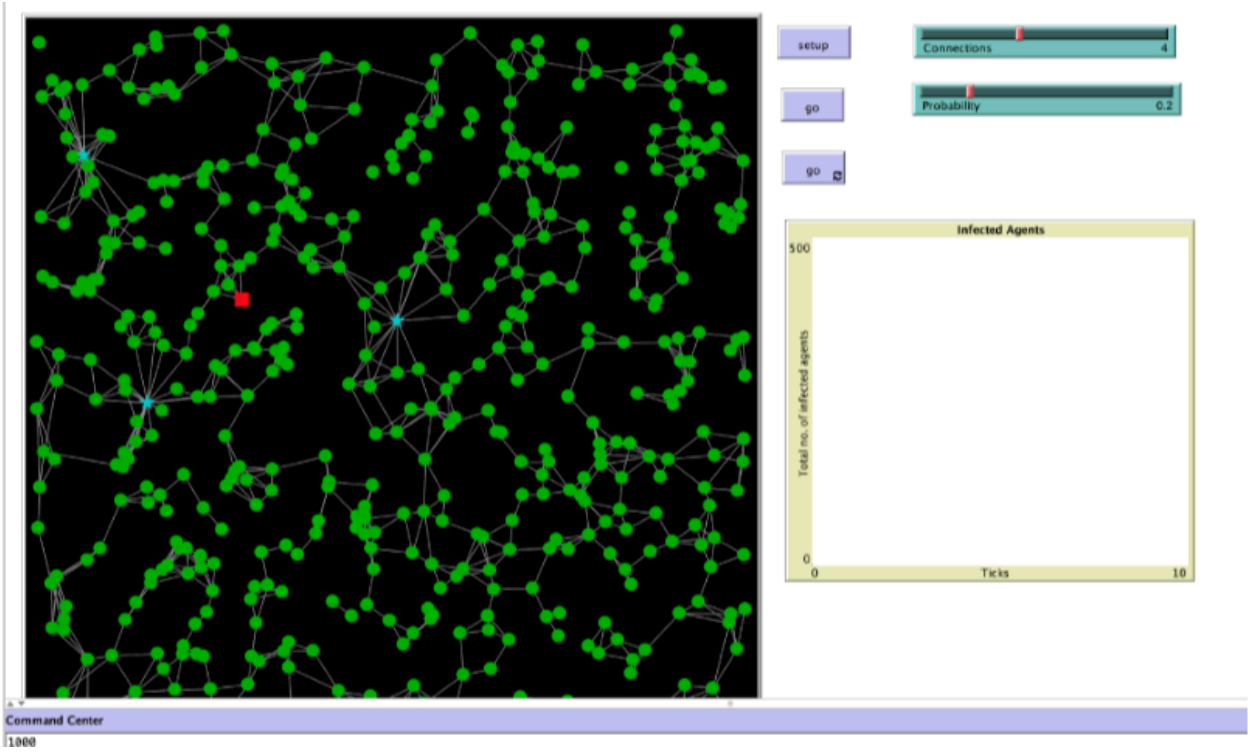
To make it easier to navigate the model used in this step, we have created **downloadable instructions** for you.

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



The layout of the online version of the Virus in a networked tribe with hubs model (Model 2)

Alternatively, you can also download **Virus in a networked tribe with hubs** (Model 2). For this, go to the on-line model, click on export netlogo, and store the file model2.nlogo. If you have not done so, you can download **Netlogo**. Next, open your netlogo, go to "file", "open" and find the "model2.nlogo" in the folder where you saved it.



The layout of the download version of Virus in a networked tribe with hubs (Model 2)

What do you see?

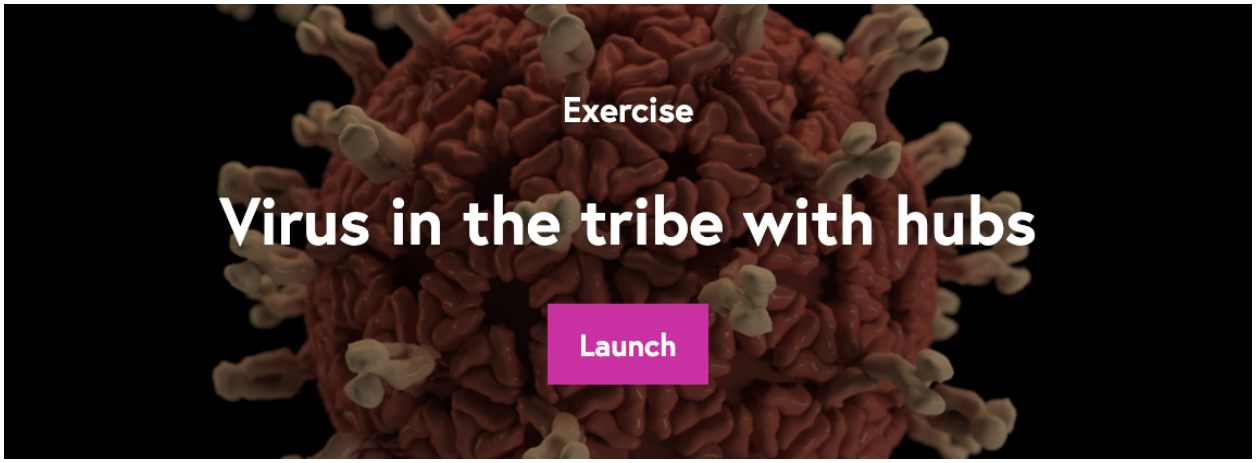
- Opening the model shows you our virtual tribe of 500 nodes with the green and the single infected red node. New in comparison to the **Virus in the tribe model** (Model 1) from last week are the **blue stars**: these represent the hubs, and as you can see, these blue-star-nodes have more connections than the regular nodes.
- What you can do is the same as with the Virus in the tribe model, namely define the number of links each node has by setting **connections**, and set the chance that another node is being infected with the value of **probability**. In the default setting the nodes have 3 links, and the chance of infecting another linked node is 20% every time step.
- Clicking on **go** will show one time step, clicking on **go**↻ will run the model continuously. You can observe how many nodes are being infected as they turn red. As an overall measure, the graph shows the number of infections over time.

Things to explore

1. Starting with the basic setup shows you how the virus spreads through our simulated tribe under this default condition. Run this default setting of the simulation model multiple times by clicking on **go**↻ repeatedly, and observe the speed of the spread of the virus. In particular look close what happens with the spreading of the virus if a hub gets infected.
2. Experiment with different settings of **connections** and **probability**. Compare the spreading dynamics of this model with the Virus in the tribe model (Model 1) from last week.

What do you observe?

Please note, by clicking 'Launch' you will be taken to a page containing content provided by a third party website.



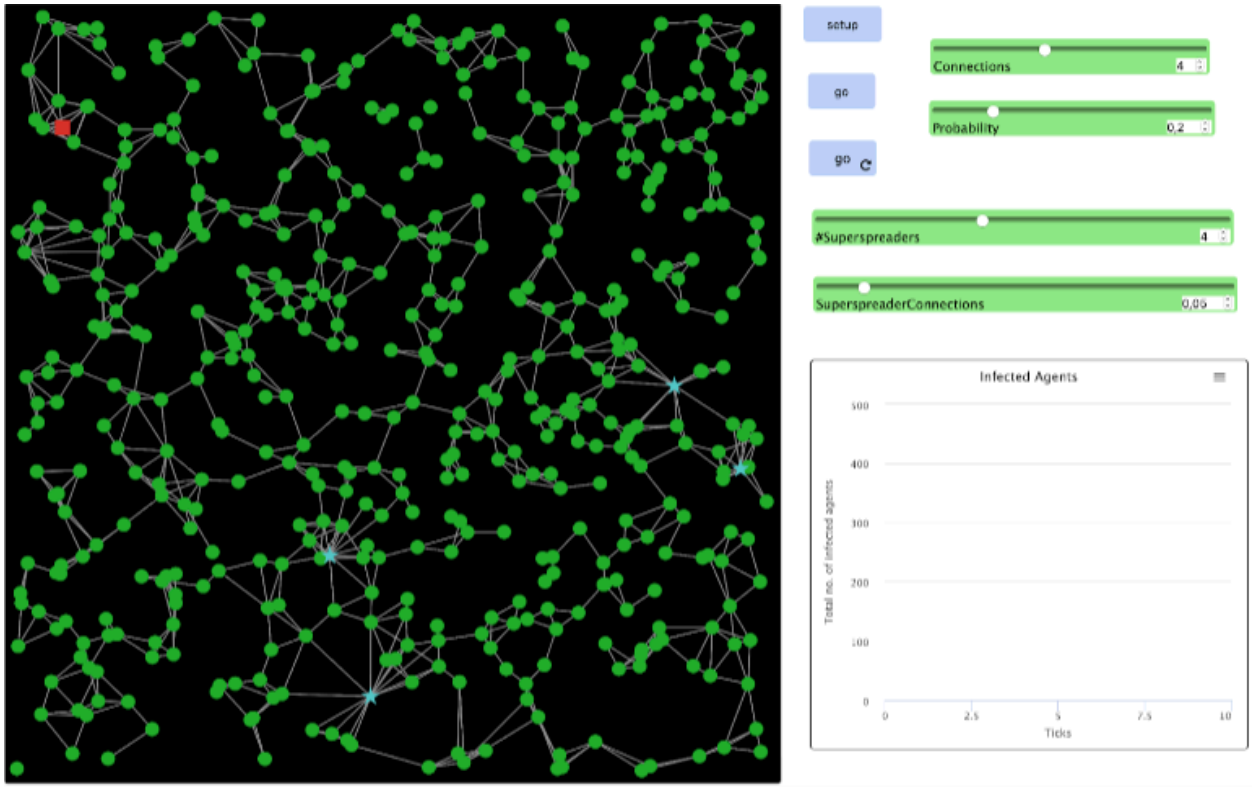
6. Virus in the tribe with connectivity of hubs – EXERCISE

In this exercise you will use the same model of a networked tribe we used for the previous exercise. However, we have expanded it, so that now you can also actively decide how many hubs there are in the network, and how many connections they have.

Setting up

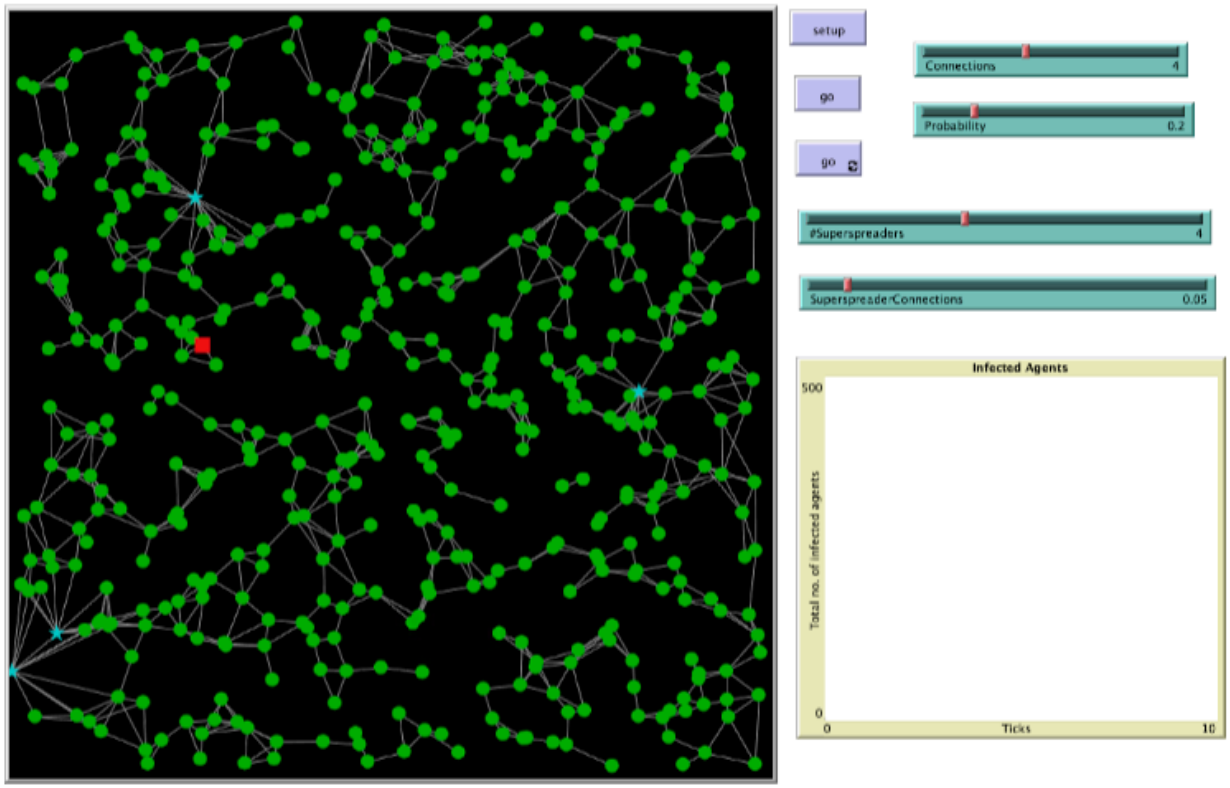
To make it easier to navigate the model used in this step, we have created **downloadable instructions** for you.

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



The layout of the online version of Virus in the tribe with connectivity of hubs model (Model 3)

Alternatively, you can also download **Virus in the tribe with connectivity of hubs model** (Model 3). For this, go to the on-line model, click on **export netlogo**, and store the file **model3.nlogo**. If you have not done so, you can download **Netlogo**. Next, open your netlogo, go to "file", "open" and find the "model1.nlogo" in the folder where you saved it.



The layout of the download version of Virus in the tribe with connectivity of hubs model (Model 3).

What do you see?

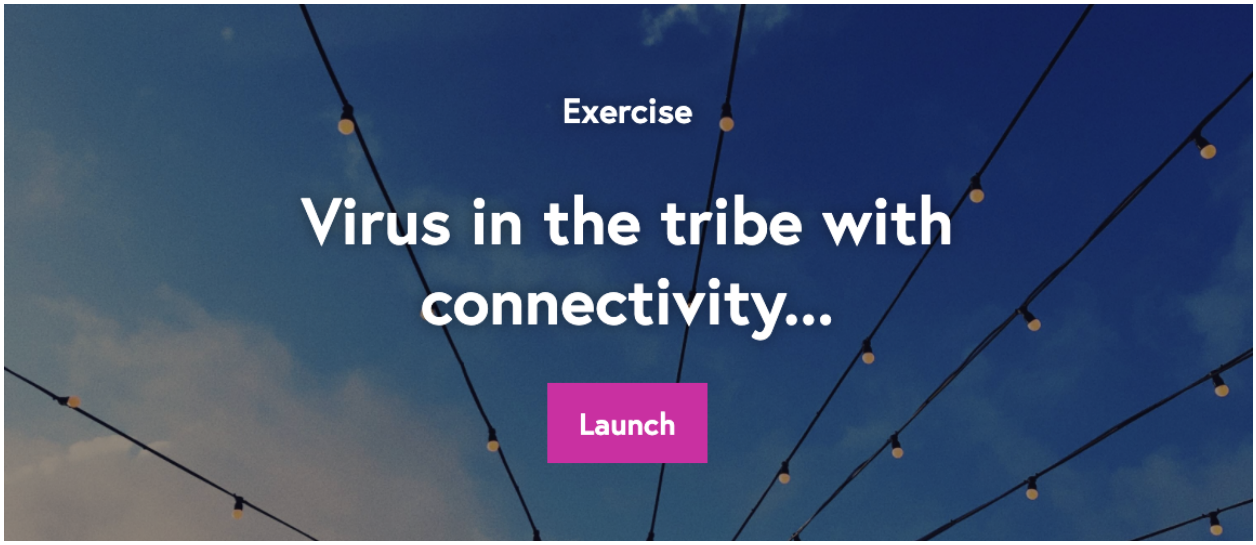
- Opening the model shows you our virtual tribe of 500 nodes with the green and the single infected red node. New in comparison to the Virus in the tribe with hubs model (Model 2) from the previous step are the sliders for #superspreaders, which allows you to define how many hubs there are in the network, and SuperspreaderConnections, which allows you to define how many links a superspreader has.
- Clicking on go will show one time step, clicking on go↻ will run the model continuously. You can observe how many nodes are being infected as they turn red. As an overall measure, the graph shows the number of infections over time.

Things to explore

1. Starting with the basic setup shows you how the virus spreads through our simulated tribe under this default condition with 4 superspreaders with a limited number of contacts. Run this default setting of the simulation model multiple times by clicking on go↻ repeatedly, and observe the speed of the spread of the virus. In particular look close what happens with the spreading of the virus if a hub gets infected.
2. Now increase the SuperspreaderConnections. What do you observe with the spreading of the virus?
3. Set connections at 2, Probability at .2, the #superspreaders at 1, SuperspreaderConnections at .50. Now we have a situation where in model 1 the diffusion of the virus was most of the time very limited. What is the impact of having one superspreader in the network?
4. Now, experiment with different settings of **connections** and **probability**.

Compare the spreading dynamics of this model (Model 3) with that of the previous step Virus in the tribe with hubs (Model 2). What do you observe? Please share your observations with other learners.

Please note, by clicking 'Launch' you will be taken to a page containing content provided by a third party website.



7. Questions about hubs – QUIZ

Use these questions to check your understanding of hubs.

Quiz rules

- Quizzes do not count towards your course score, they are just to help you learn
- You may take as many attempts as you wish to answer each question
- You can skip questions and come back to them later if you wish

QUESTION 1

Are hubs "born that way" or do they always have to grow their status, following preferential attachment dynamics?

They are always "born that way" in a network

They always grow on the basis of preferential attachment

Hubs can inherit their position but also grow following preferential attachment dynamics

QUESTION 2

Do hubs, such as presidents, kings, artists and other influencers, have more impact on society in these modern times than in ancient times due to the large media networks (e.g. the internet)?

Difficult to say, because there is also more competition between a larger number of hubs.

Yes, because hubs can reach out to millions of people using modern media.

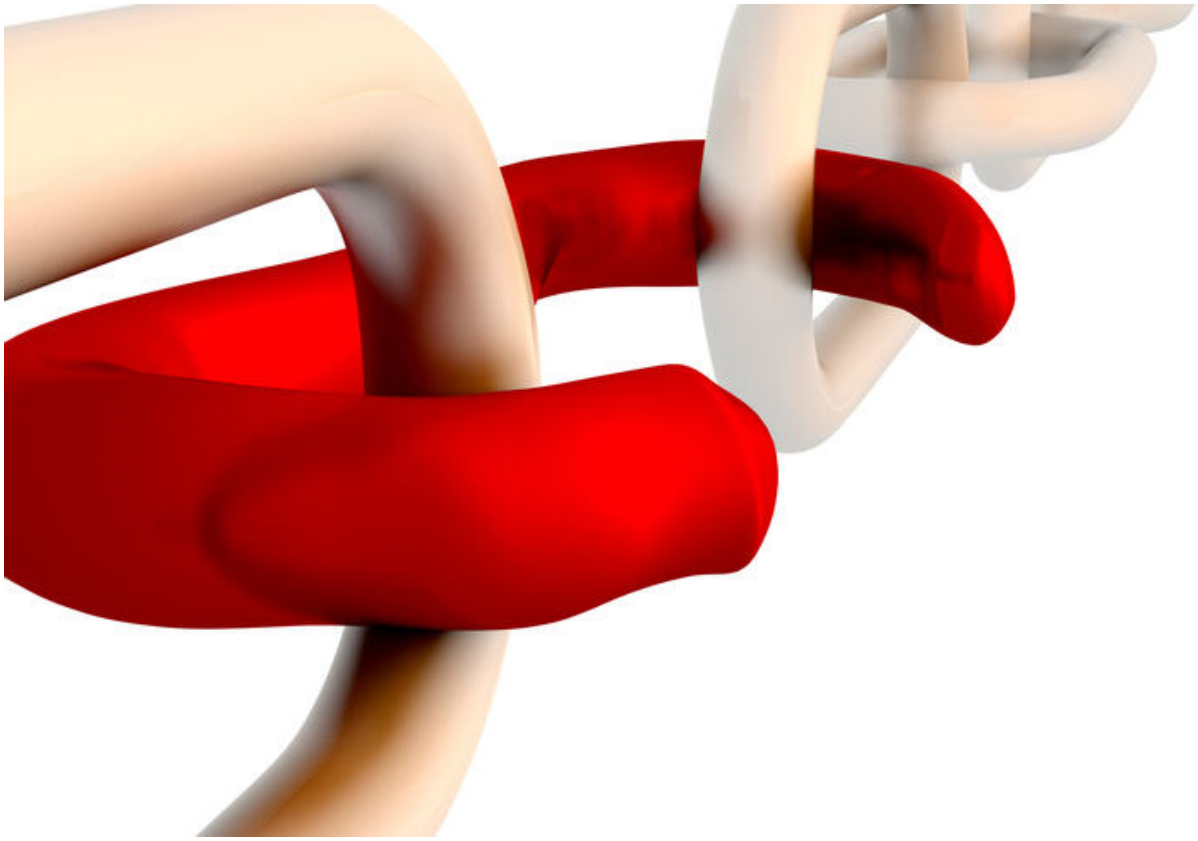
No, because the hubs had much more power in ancient times, often being feudal governors that had absolute power.

8. Preferential attachment in your life – DISCUSSION

As discussed, preferential attachment relates to the preference of getting into contact with a person already being popular/having a lot of contacts.

Can you think of real-life examples of preferential attachment dynamics? Can you think of situations where you tried to connect with a more popular person? Do you follow any "hubs", and in which way do they affect your opinions and preferences? We invite you to share your examples and experiences in the discussion section.

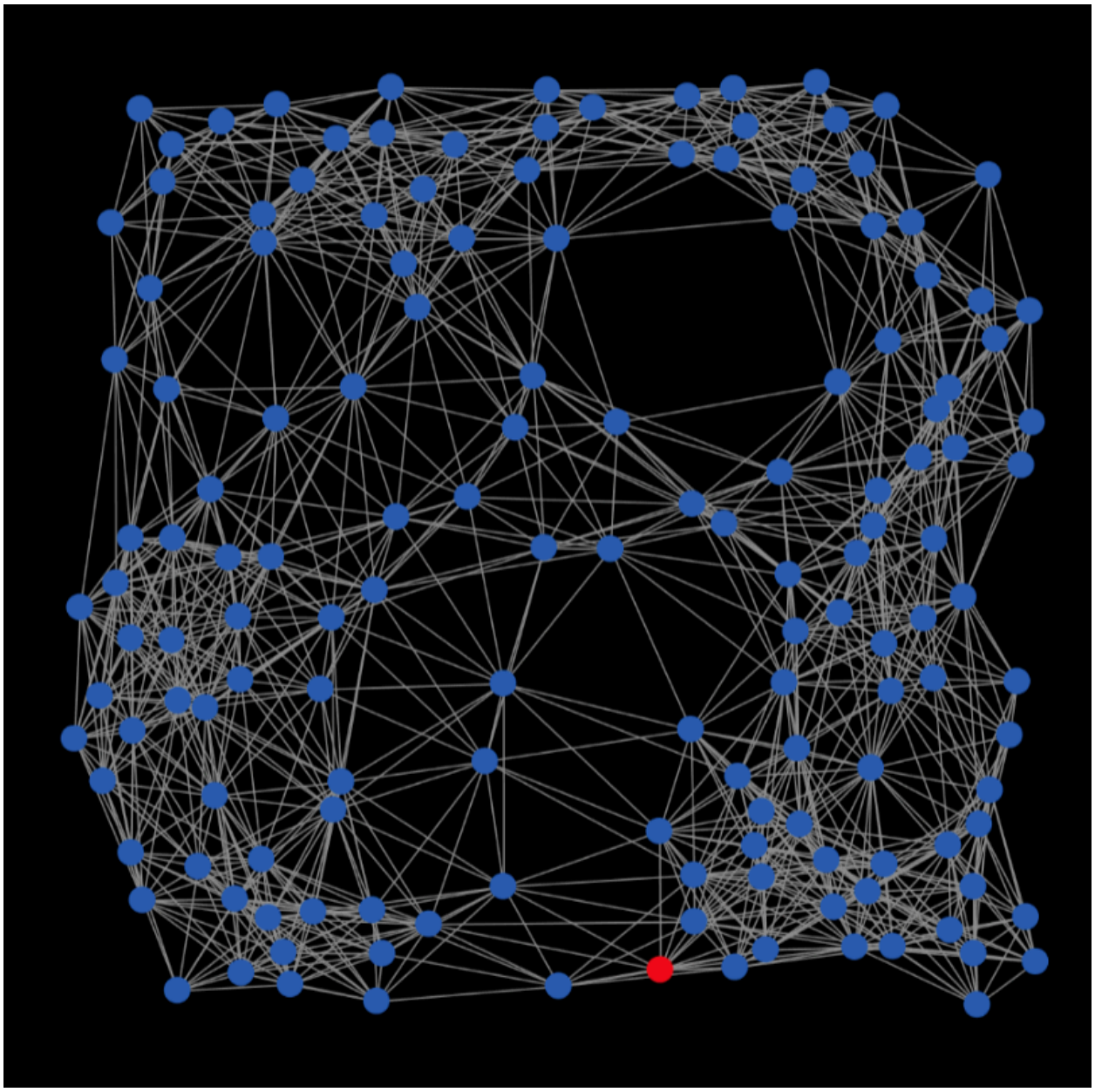
9. Weak links and preferential attachment – ARTICLE



Two important characteristics of larger networks, such as those arising in agricultural societies, are (1) the principle of weak links, and (2) preferential attachment.

Weak links can be considered to be the travellers that connected the different communities of people. Some of these ancient travellers are still recognised today, such as Marco Polo who travelled the silk route and fostered a connection between Persian, Indian, Chinese and European cultures.

Weak links are playing a crucial role in transferring information of goods from one cluster of nodes to another one. They can be seen as bridges that connect different, more clustered parts of networks, and thus play an important role in spreading information. In simulated networks these weak links can be seen as the nodes that are not central in clustered groups of nodes, but rather have a **bridging** position between clusters, as for example the red node, that connects the clusters on the bottom left and right.



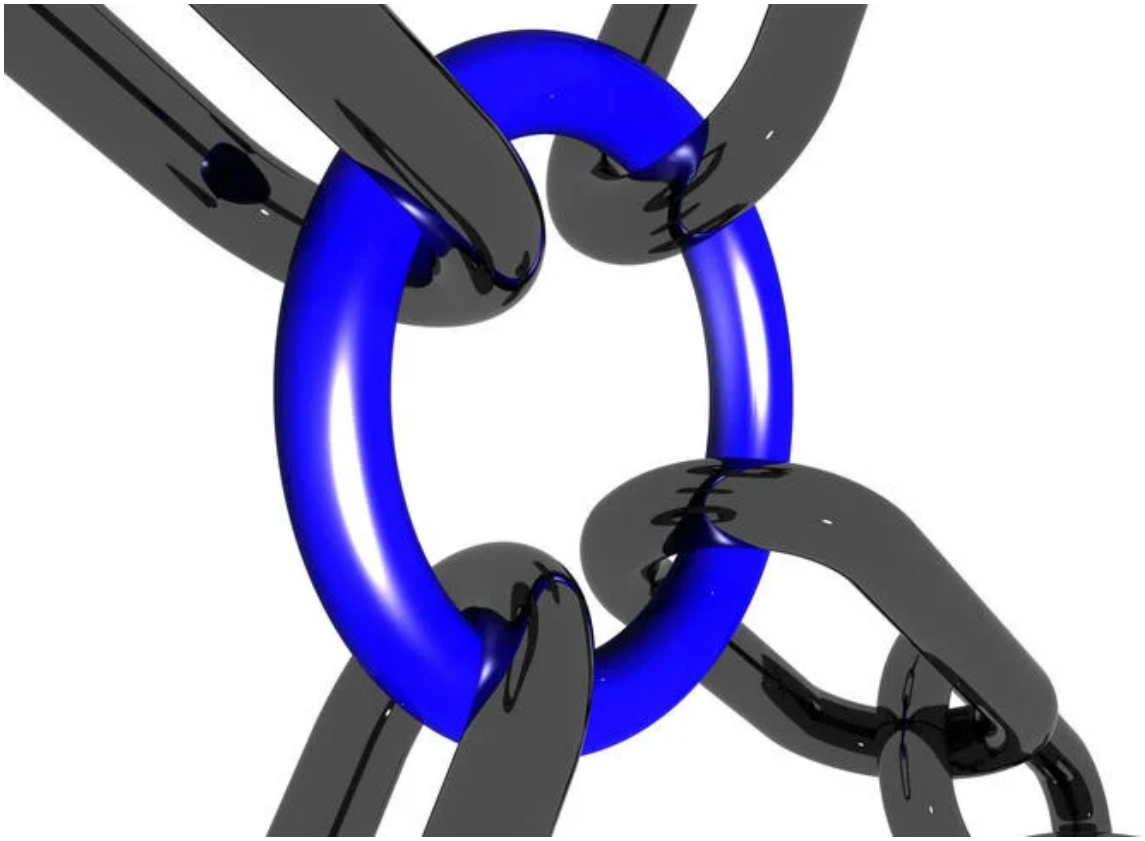
The red node connects two clusters

Preferential attachment is the basic mechanism behind why kids want to be friends with the "popular kid". It is always beneficial to have powerful friends, because aligning with them may also contribute to your social status. Moreover, powerful friends may help you when you are in need. On the other hand, the legitimacy of power is depending on how many people follow the powerful person. We can understand this as an emergent process: people like to follow popular others, and popularity grows on the number of followers one has. Popular and powerful people used new technologies such as book printing to widely share their ideas with many others.

A key insight is that these weak links and preferential attachment principles do not replace the older tribal network structures, but rather add to them, strengthening the connectivity between families and tribes. They can be understood as contributing to the "densification" of the network between people.

Whereas in the old tribal networks certain information and social practices are being shared, the densification added new layers of influence, such as authority, economic and military power. In understanding social networks, therefore, it is important to realise that we all take part in different networks, and that they all play different roles in our daily life. We may talk with our parents over dinner, go to school or work to learn and earn money, visit friends to discuss politics or the newest products and fashion, and read books of influential writers and watch politicians on the news.

10. Hubs and weak links– DISCUSSION



In the previous steps, you have been exploring the role of hubs in a network, but we also discussed the role that "weak links" play in connecting different clusters in the network.

What is the impact of hubs in the diffusion of a virus? And what is the role of weak-links in the spreading of a virus? Can you relate this to real world examples? What implications does this have for a strategy to control the spread of a virus?

Can you give examples of how "hubs" and "weak links" play a role in other domains (e.g. opinions, products, practices) than the spread of a virus?

11. Questions about network properties and hubs - QUIZ

With the help of these questions, you can check your understanding of the key concepts of degree distribution, preferential attachment and the role of hubs in networks.

Quiz rules

- Quizzes do not count towards your course score, they are just to help you learn
- You may take as many attempts as you wish to answer each question
- You can skip questions and come back to them later if you wish

QUESTION 1

What does a high degree distribution in a network mean?

- **This means that a few people have a lot of links, whilst the majority has fewer links.**
- This means that all the people all have a high connectivity in the network.
- This means that there is a high equality concerning the number of links that people have.

QUESTION 2

What is the effect of preferential attachment in networks? Please select all correct answers.

- Select all the answers you think are correct.
- **It causes that famous people become more attractive to connect with contacts.**
- **It is responsible for the emergence of hubs in networks.**
- **It causes that the number of contacts people have follow a fat-tail distribution.**

QUESTION 3

What is the impact of hubs on the diffusion of information through networks?

- **It speeds up information exchange.**
- It does not affect information exchange.
- It slows down information exchange.

12. How much interaction did you have today through which channels? – DISCUSSION

We are often hardly aware of the many interactions we have on a daily basis. We talk, send e-mails, watch people on television sharing news and opinions, read reviews, just to name a few. This discussion step is meant to make you aware of the richness of your interactions in a network, and share your experiences with other learners.

List the (meaningful) interactions you had today with other people, both in real life or through a media channel (e.g. a broadcast). Write down the following things

1. what channel,
2. if it was a two-way interaction, like in a talk with a friend, or an instagram interaction, or a one-way interaction, as watching a TV-personality or reading an article, and
3. what was the content (news, sporting, studying together).

Finally, indicate if the opinions of other people (e.g. politicians, influencers) were involved in that interaction (e.g. in the news). How many meaningful interactions did you have in total? Please share this with your fellow learners.

Check out the posts of your fellow learners. Do they report similar lists (homogeneity), or is it very different (heterogeneity)? Do you notice any outliers, suggesting that they may be taking on the role of a hub?

13. Exchange of information – VIDEO

In this video Wander Jager explains that information is spreading differently through social networks than a virus. Moreover, hubs may be followed by many people, but they don't follow back, indicating that links are "directed". Additionally, norms play a role in networks, and also norms operate differently on a network than the spreading of a virus.

In which situations do you usually follow the norm, and in which situations do you (sometimes) deviate from the norm? How do you feel when you are deviating from the norm?

Please share this in the discussion section and discuss with other learners.

14. The impact of social norms in networks - ARTICLE

In our lives, we often have to make choices between products, political parties, or take a stand in a discussion. Obviously, we can collect information on the merits of one product or idea over another, especially when the internet offers us abundant information on the merits and disadvantages of almost all choices we are confronted with. Just think about the product reviews you can find on the internet. In this way we can determine the so-called utilities of products and ideas, and decide on what is best for us.

However, is our choice being appreciated by those around us? Do the people you are connected with appreciate it when you have a deviant opinion, or choose a different brand than they do? This refers to the social norms that are often important in our lives.

Being a very social species, people generally dislike feeling like outcasts, and we fear social exclusion. As a result, we have a tendency to conform to what is "normal" in the group. The tendency to conform to what the majority of the group is doing may determine your behaviour, especially when it concerns very visible and communicable products or opinions. For more privately-used products, like rice or cleaning products, this norm will not be very important; mind that people may still inform each other about the experiences they have with a product, e.g. through product reviews. For very visible products, such as clothing or smoking, the norm may be very strong, and people may end up smoking or wearing uncomfortable business apparel to comply to the norm and avoid social exclusion.

When the communities in agricultural society got larger, and the first cities emerged, the people could observe the behaviour of many more people, whilst the number of informational interactions that require more time would remain on a lower level. Thus, the norm became more important in larger communities, and fashions and social practices became important as normative parts of culture on how to behave in larger societies.

Therefore, social norms may cause you to choose a product or comply with an opinion that you personally do not prefer. However, you still choose to avoid negative responses from those around you. This means your behaviour is based on a combination of your personal preferences and the social norms that you experience. Sometimes you might comply to the norm, even is this means deviating from your personal preferences. Much of our behaviour is driven by these normative forces, and they may play a critical role in the success or failure of changes in society.

The following video demonstrates the classic Asch experiment on conformity, showing how strong the normative pressure can be.

15. Informative influence in the tribe – EXERCISE

In this exercise you will use the same networked tribe we used in the Virus in the tribe exercise steps in Week 1 and earlier this week. In the previous experiments you explored how a virus spreads through a network. Here we will focus on how products, opinions or ideas spread through our tribe. In the following we will use the word "product" in the description, but please bear in mind that this includes opinions and ideas.

A virus is transmitted in a relatively simple manner; an interaction may cause the virus to jump over and infect the other person. In a social simulation model we can simplify this, as the probability that a contaminated agent will also contaminate another linked agent.

The adoption - or not - of a product works differently, as it requires a decision of a person. As we mentioned in the preceding step on social norms, people may decide to adopt a product based on the **product characteristics**, or utilities, but also on the basis of what their linked others are consuming, which may impose a norm.

Information on **product characteristics**, such as price, quality and service, can be acquired in two ways: trying out a product for yourself, or getting information on the product from a linked neighbour.

The normative influence depends on the distribution of product consumption of the linked neighbours: If they all use green products, the norm is clearly in favour of green products. If however half of the neighbours consume red, there is no clear norm.

In our exercise we start with 2 products: red and green. You can set up how many agents initially consume the red or green product, and also change the quality of these products when the simulation runs. You can experiment with how the importance of the norm affects the choice behaviour of the agents. This may range from totally unimportant, where the agents purely decide on the product characteristics (e.g., rice or clearing products), to the other extreme, where the product characteristics don't matter but only complying to the norm is important (e.g. smoking, fashion).

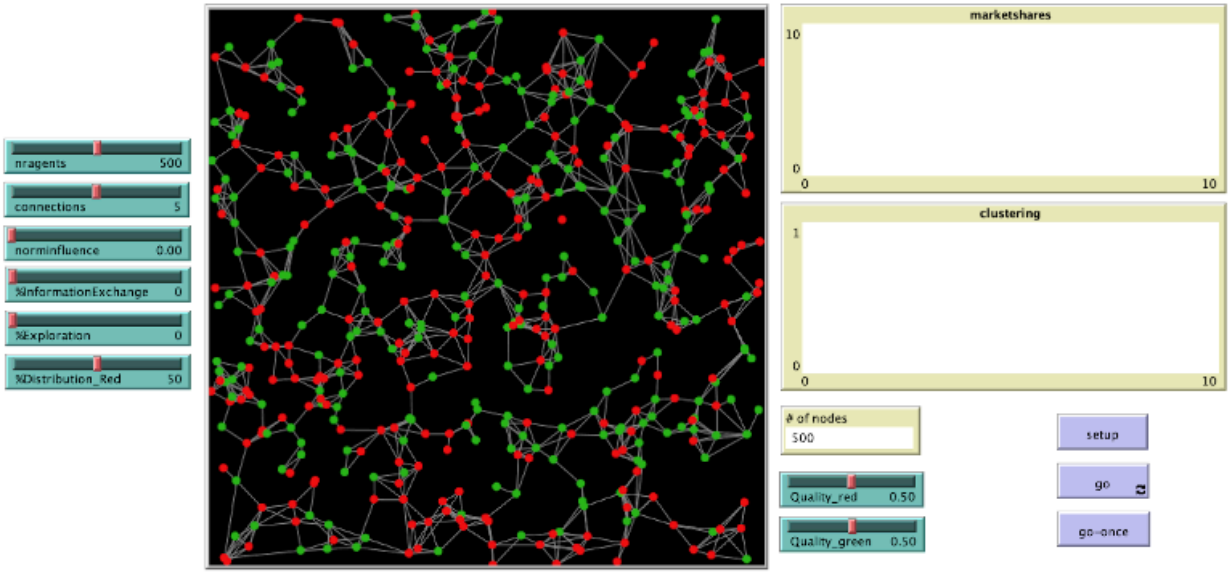
You can also experiment with how the agents get their information about the product characteristics by

1. changing the frequency of trying out a product and
2. changing the frequency of asking neighbours about the product characteristics.

Setting up

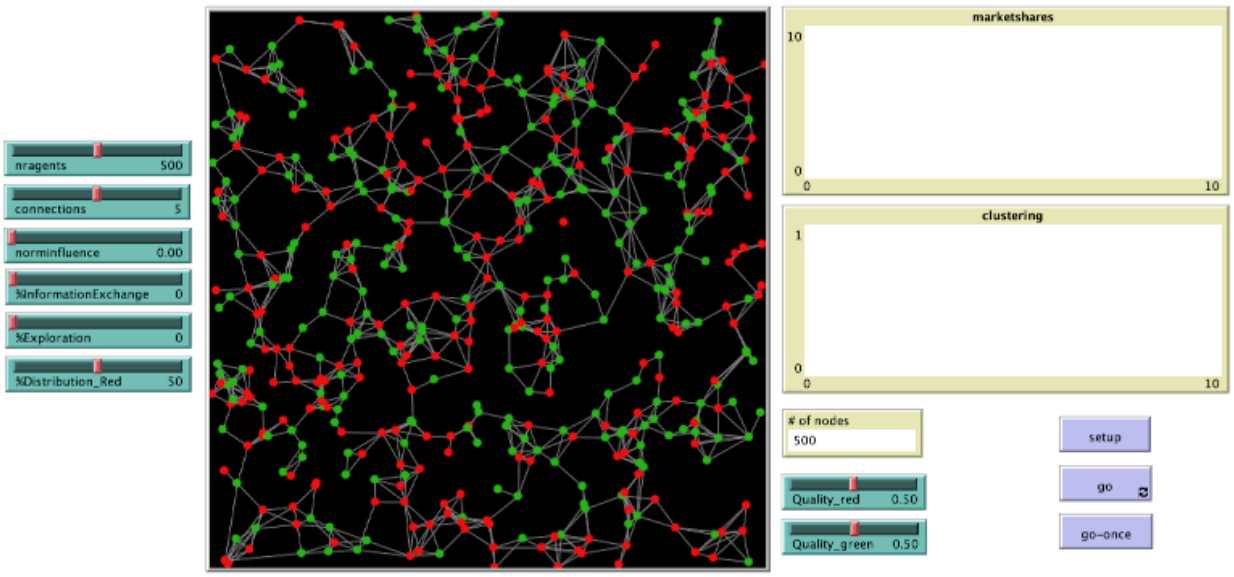
To make it easier to navigate the model used in this step, we have created **downloadable instructions** for you.

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



The layout of the on-line version of Information and norms in the tribe model (Model 4)

Alternatively, you can also download the **Information and norms in the tribe model** (Model 4). For this, go to the on-line model, click on **export netlogo**, and store the file **model4.nlogo**. If you have not done so, you can download **Netlogo**. Next, open your netlogo, go to "file", "open" and find the "model1.nlogo" in the folder where you saved it.



The layout of the download version of Information and norms in the tribe model (Model 4).

What do you see?

- Opening the model shows you our virtual tribe of 500 nodes with 250 green and 250 red nodes. Each node has 5 links, and with **connections** you can adjust the number of links each agent has with the slider **connections**.
- Clicking on go will show one time step, clicking on go↻ will run the model continuously. You can observe how agents change of colour and thus choose the green or red product.
- In the graph **market shares** you can observe the percentage of agents that consume respectively the green and the red product. The **clustering** shows the clustering index of the consumer behaviour, showing how much similar the product consumption of linked agents is.
- The important sliders to experiment with the interaction between the agents are norminfluence, %InformationExchange and %Exploration.
- **norminfluence** indicates how sensitive the agents are for the choice of other linked agents. If norminfluence is set at 0, they don't care about norm but just decide on the basis of product quality. On the contrary, if the norminfluence is 1.0, the agents only decide on the basis of what their linked neighbours are doing, and they will adopt the choice of the majority of their neighbours, irrespective of the product characteristics.
- **%InformationExchange** refers to the communication between the agents on product characteristics. Setting this for example at 10 means that in 10% of the time steps the agent will ask a neighbour

after the product characteristics of the product the neighbour is consuming, and updating its memory. In this way an agent can learn from neighbours about a change of the product characteristics.

- **%Exploration** is an individual learning strategy. Setting this at 1 means that in 1% of the steps the agent will choose a random product. In this way it may also learn if a product characteristic has changed.
- **%Distribution_Red** allows you to set the initial proportion of agents that use red.
- Mind that the agents also have a habitual mechanism, meaning that they may continue using a product despite being informed about the better quality of an alternative opinion/product.

Things to explore

1. In the default setting we have set norminfluence, %InformationExchange and %Exploration at 0.
2. Quality_red and Quality_green are equal, and set at .5. Also the initial distribution is equal, having %Distribution_red at 50.

Obviously, you are free to explore the model and play with different settings. However, we have prepared a few standard experiments to illustrate some network dynamics related to sharing information and the influence of norms.

Experiment 1: Default setting

Run the model and change the product quality of red and green. You will observe that the agents will not change their behaviour at all. This makes perfect sense, because once they use a product, they don't explore the alternative product, nor are they being informed by neighbours using a different product about the quality of the product. There is also no normative influence, hence no matter how much you change the product quality, the agents will not change their behaviour.

Experiment 2: Adding exploration

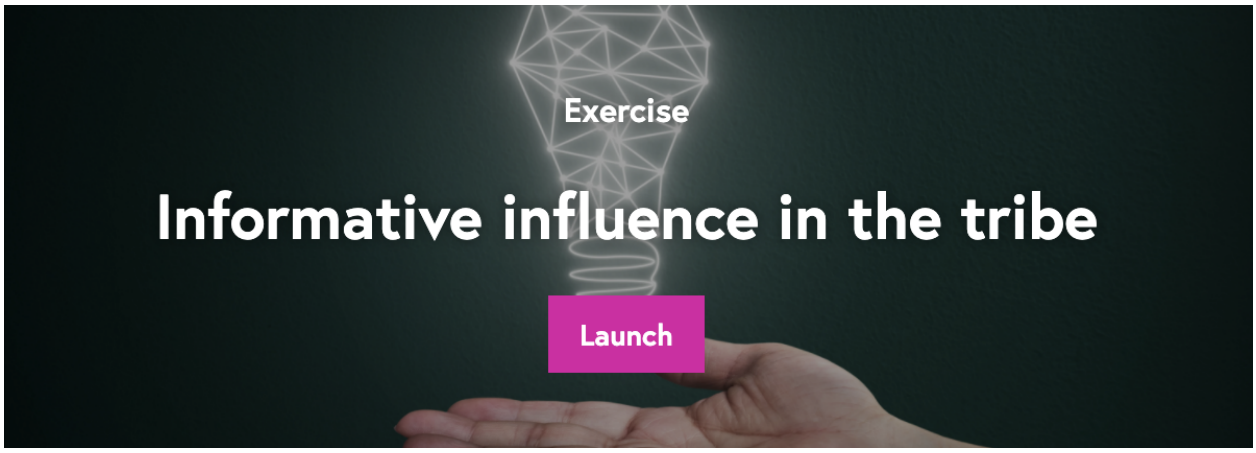
Run the model, and now change %Exploration to a value of 10. This means that the agents will occasionally try the other product, and thus learn about its characteristics. What do you observe with the market shares?

Now change the quality of the products, for example, set the Quality_red at .55. What do you see happening?

Play around with different settings for product quality and %Exploration, and explore how fast the market is responding.

Often it is assumed that because of the sharing of information people will always end with choosing a product or opinion that is most beneficial for them. Particular ideas on the "free market" often assume that this outcome-maximizing behaviour of people causes that society as a whole will select the most beneficial behaviour. Do the experiments in this step support this idea? Do you think that people with information operate in this way?

Please note, by clicking 'Launch' you will be taken to a page containing content provided by a third party website.



16. Adding informational exchange into the tribe – EXRCISE

In the two experiments in the previous steps the agents were individualistic decision-makers. They do have links, but do not exchange any information at all. In this experiment we will allow for information exchange between the agents, which implies sharing their experience with product quality through their links.

We will use the information and norms in the tribe model (Model 4) from the previous step again, so you either choose again to run this exercise from the web by pressing the launch button at the bottom, or you can run it locally.

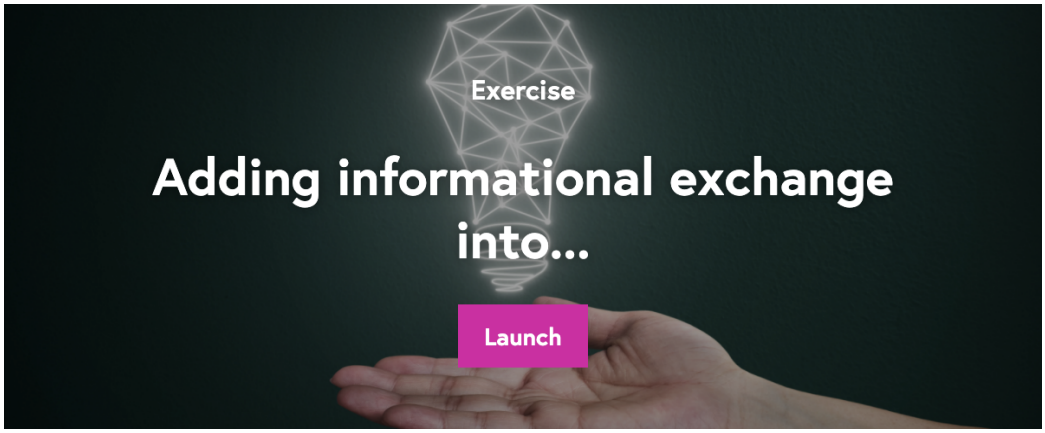
To make it easier to navigate the model used in this step, we have created **downloadable instructions** for you.

Things to explore

1. Set norminfluence at 0, %InformationExchange at 20 and %Exploration at 0.
2. Now make the red product more attractive by setting it's quality at .75, and the quality of green at .25.
3. Run the model. What do you observe?
4. When all the agents use the red product, reverse the qualities of the products to red .25, and green .75.
5. Despite the green product having superior quality, nobody is starting to use it in this condition. Can you explain why?
6. Now change %Exploration to 10 and observe what is happening.

As you see, only when information becomes available through exploration, information on the new product becomes available to the agents, and they can act upon this information.

Please note, by clicking 'Launch' you will be taken to a page containing content provided by a third party website.



17. When information is not being shared – DISCUSSION

Things to discuss

In the simulation exercise you noticed that it is possible that a superior product fails to spread through a network. When nobody is using the superior product, the information on this product is not being shared. If nobody knows about it, this superior product will not spread over the network.

An example could be the **Velotype**, a keyboard that allows for much faster typing than the qwerty keyboard that many of us are using. Whereas there is also a path dependency effect playing a role in this example, a key observation is that basically nobody is using a Velotype keyboard, and hardly anyone is aware of its existence, although this may clearly be a superior product. This phenomenon is also called **lock-in**.

Can you give more examples of such situations where a superior product did not make it, and society is locked in the use of an inferior product?

Additional reading

On path dependencies and lock-ins the following **Wikipedia entry** is interesting to read.

18. Normative influence in the tribe– EXERCISE

In the following steps and experiments we will activate the normative influence in the tribe.

We will use Information and norms in the tribe model (Model 4) from the previous exercise step again, so you either choose again to run this exercise from the web by pressing the launch button at the bottom, or you can run it locally.

To make it easier to navigate the model used in this step, we have created **downloadable instructions** for you.

Things to explore

As a reminder, **norminfluence** indicates how sensitive the agents are for the choice of other linked agents. If norminfluence is set at 0, they don't care about norm but just decide on the basis of product quality. On the contrary, if the norminfluence is 1.0, the agents only decide on the basis of what their linked neighbours are doing, and they will adopt the choice of the majority of their neighbours, irrespective of the product characteristics.

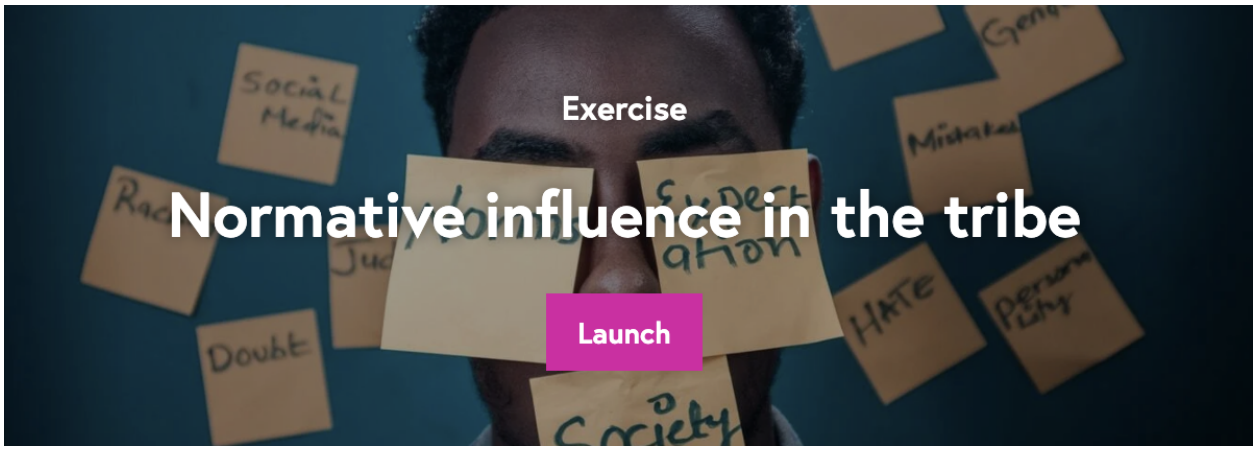
Experiment 4: Adding normative influence

Now we will explore how changing product quality may affect the market share for situations where the norm is more or less important. Think of the examples of clothing and smoking, where the norm is important in contrast to cleaning products and rice.

- Set norminfluence at .20, %information at 20 and %Exploration at 1.
- Set Quality_red at 0.50 and Quality_green at 0.50.
- Run the model. What do you observe concerning clustering?
- Run the model several times by clicking on the setup button.

What do you observe with respect to the market shares of the products (mind that they are having a similar quality). How can you explain this?

Please note, by clicking 'Launch' you will be taken to a page containing content provided by a third party website.



Exercise

Normative influence in the tribe

Launch

19. A normative lock in – EXERCISE

Let's do another experiment with the information and norms in the tribe model (Model 4).

To make it easier to navigate the model used in this step, we have created **downloadable instructions** for you.

Things to explore

- Set norminfluence at .20, %information at 20 and %Exploration at 1.
- Set Quality_red at 0.55 and Quality_green at 0.45.
- Let the simulation run for a while, and you will see the red product dominating the market.
- Now, whilst the simulation is running, change Quality red at 0.45, and change Quality green at 0.55. We now have the situation where the green product has a higher quality than the red product, and the agents are being informed about this.

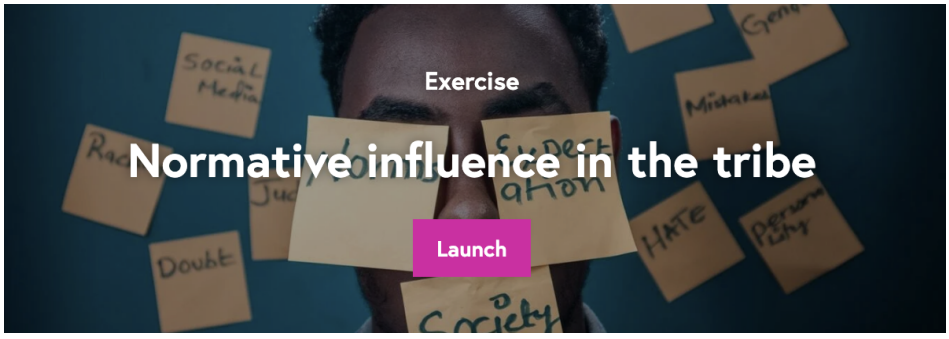
What do you observe in this experiment? Can you think of similar situations in the real world where a lower quality product is still dominating the market?

Try stepwise to make the green product more attractive and the red product less attractive. Explore how much better the green product must be before it is capable of breaking through the norm that is in favour of the red product.

Finally, please take the time to experiment with how the changes in market shares of the green and red product depend on combinations of norminfluence, %InformationExchange, %Exploration at 10, Quality, connections and initial distribution.

Were there surprising outcomes? Please share your experiences with other learners?

Please note, by clicking 'Launch' you will be taken to a page containing content provided by a third party website.



20. Diffusion curves – EXERCISE

When a new product enters a market, or the quality of a product is changing, the market may respond differently to that. Some changes are picked up very quickly, whilst other innovations take a lot of time to be adopted by the market, or do not diffuse at all. Norms play an important role here. The same can be said about for example political movements, fashions and memes: norms may have a strong impact on how they spread through a network.

In the following experiment we will have a close look at the diffusion curves that we observe in the marketshares table, as this shows how slow or fast a change in product quality spreads over a network.

To make it easier to navigate the model used in this step, we have created **downloadable instructions** for you.

Things to explore

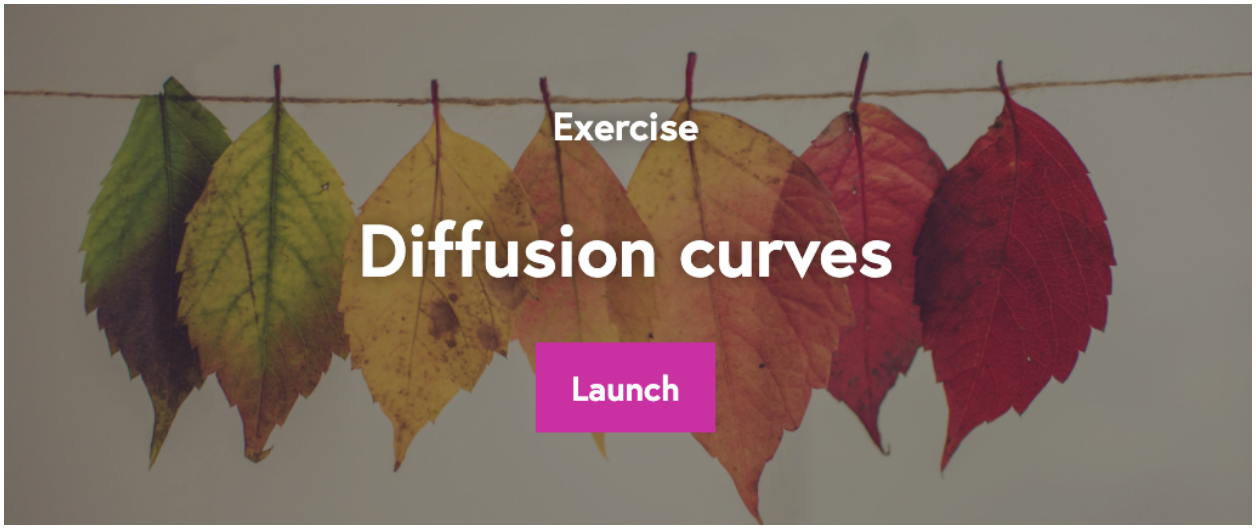
- Set norminfluence at .0, %information at 20 and %Exploration at 35.
- Set Quality_red at the max 1.00 and Quality_green at 0.50.
- Run the model and wait till red takes over the market share.
- Then set Set Quality_red at .50 and Quality_green at the max 1.00. You will observe the green product will quickly dominate the market.
- Now set norminfluence at .15, and following that switch Quality_red back to its original 1.00 value and Quality_green at 0.50

Take a close look at the S curve in the marketshares graph when green takes over the market under no-normative influence, and the next S curve when green loses its market share under conditions of normative influence.

You will observe that the curves are different if norms are present or not. When norms are influential, the better product will find it difficult to spread as long as there are just a few agents adopting the better product. However, when a majority has adopted the better product, it now will also be supported by the norm, and the spreading of the better product will go even faster.

Fashion is often a very norm driven phenomenon. Can you give examples of the rise of certain fashions? Do these follow the S-curve as discussed?

Please note, by clicking 'Launch' you will be taken to a page containing content provided by a third party website.



21. Social norms and tipping points in networks – ARTICLE

Theory on innovation diffusion describes how a critical mass of connected people adopting a new behavior can spread a norm change through a social network.

Take smoking as an example. In the past it was quite common that people were smoking indoors, even inside the house of non-smokers. However, a group of well-educated people realized that smoking is a very unhealthy habit, and decided either to quit, or not to start at all. In the beginning, in a few places this resulted in non-smoking inside of houses. Soon this norm was spreading, also supported by policies that banned smoking in public spaces.

In terms of innovation diffusion, we can say that pioneers may invent a better behaviour. If others recognize individual benefit of this behaviour, a local cluster of adopters may emerge. The more socially infectious this group is, and the more visible, and easy to copy the new behaviour, the faster and wider the behaviour will spread. Role models or hubs are often critical in this process. The tipping point occurs when sufficient positive normative feedback emerges, causing the new behaviour to become normal.

The theory of Innovation Diffusion by Everett Rogers (1962) has become very influential in explaining how this works. In the graph below you see the yellow S-shaped curve indicating how many people adopted the

new behaviour or product. The blue normal distribution explains how many people fit in the category of innovators, early adopters, early majority, late majority and laggards.

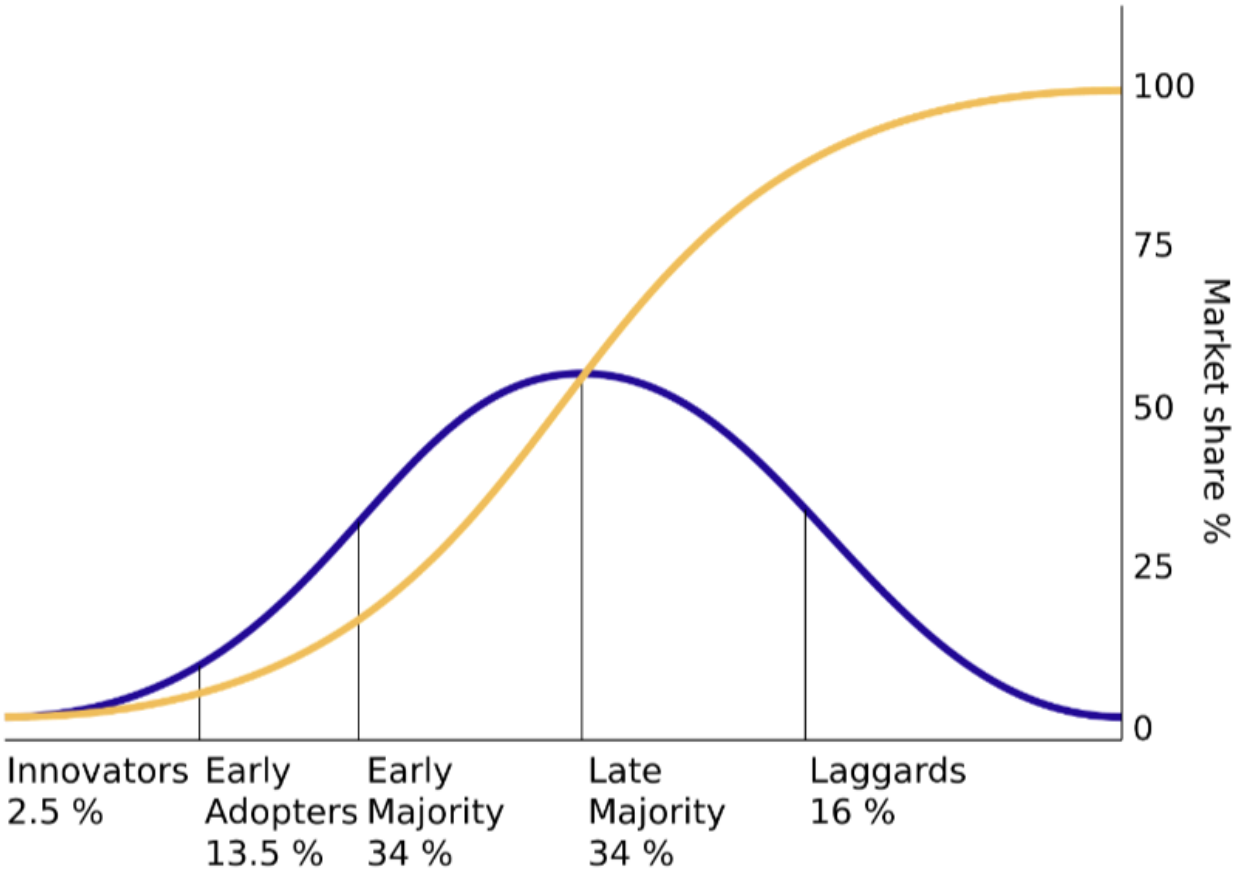


Figure: The diffusion of innovations according to Rogers (source: Wikipedia).

The tipping point in the process of innovation diffusion is where the yellow curve is demonstrating an acceleration, when the early majority starts adopting as well. This is the moment where the norm starts to actually support the new behaviour, resulting in a fastening of the innovation diffusion process.

Simulation models contribute to understanding the dynamics of such tipping points, and they are important in understanding how groups of people can change their behaviour in e.g. a more healthy or environmentally sustainable direction.

Additional reading:

For a short article on how norms play a role in processes of societal change please read:

Nyborg, K., Anderies, J. M., Dannenberg, A., Lindahl, T., Schill, C., Schlüter, M., Adger, W. N., Arrow, K. J., Barrett, S., Carpenter, S., Chapin III, S. F., Crépin, A. S., Daily, G., Ehrlich, P., Folke, C., Jager, W., Kautsky, N., Levin, S. A., Madsen, O. J., Polasky, S., Scheffer, M., Walker, B., Weber, E. U., Wilen, J., Xepapadeas, A., & De Zeeuw, A. (2016). **Social norms as solutions: Policies may influence large-scale behavioral tipping**. Science, 354(6308), 42-43.

For generic information on Rogers Theory of Innovation Diffusion please check the **Wikipedia entry**.

22. Lock-ins and norms – DISCUSSION

Reflecting on the experiments normative lock-in and diffusion curves from the last two exercise steps, why is it that product green, despite its better quality at a later stage, does not succeed in conquering a large market share?

The concept of "lock in" is often used to explain a situation where society seems to be incapable of realising a change, despite the fact that a change is perceived by all to be beneficial.

What does this exercise show concerning the role of norms in the occurrence of such lock-ins, and how to get out of a lock-in? Can you give examples of societal lock-ins where norms play an important role? How could computational social science contribute to resolving such lock-ins?

23. Questions about the impact of norms in networks – QUIZ

With these questions, you can check of understanding of the role of norms in social networks

Quiz rules

- Quizzes do not count towards your course score, they are just to help you learn
- You may take as many attempts as you wish to answer each question
- You can skip questions and come back to them later if you wish

QUESTION 1

How do norms affect the spreading of new behaviour in a network? Please select all correct answers.

Select all the answers you think are correct.

- **Norms speed up the spreading (diffusion) of new behaviours.**
- **Norms slow down the spreading (diffusion) of new behaviours.**

QUESTION 2

What is a directed network?

- A network where one hub has a disproportionate large influence on the rest
- **A network where there is a difference between ingoing and outgoing links**
- This means that all the links in a network are one-directional, as in mass-media

24. Wrapping up Week 2 – ARTICLE

This second week introduced you into the spreading of information and norms in a network, and the role of hubs.

This week you learned that **hubs** play an important role in the spreading of information on a network. The exercise with a **virus in the tribe with hubs** showed you how impactful the presence of a hub can be, as they can accelerate the spreading of a virus.

You also learned that **norms** and **information are** influences that spread differently on networks than a virus. Norms cause people to appreciate an opinion, practice, or product the more they encounter other linked others sharing the same opinion or displaying the same behaviour. Norms may also cause a superior product failing to spread over a network, because it is against the existing norm. This can be identified as a **lock in** situation. The norm thus may hamper the diffusion of new behaviour, but it may also support the diffusion. If a critical number of people has adopted, the norm may speed up the diffusion process.

This explains why the **innovation diffusion** follows the typical S-shaped curve, being slow in the beginning, to speed up when the norm becomes in favour of the innovation. Often innovation fails, but when sufficient people adopt a new behaviour, a **tipping point** is reached, and the resulting change in the norm will further accelerate the spreading of the innovation on the network.

Next week we will explore how hubs may influence a market if they deliberately support one product or opinion. This is called **endorsement**, and today many influencers can be identified on the media, most notably on the Internet, who endorse certain products or political opinions.