TRACE document

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This is a TRACE document ("Transparent and Comprehensive model Evaluation") which provides supporting evidence that our model presented in:

Examination of Cultural Dissemination with Stubbornness Model.

Based off:

Rodríguez, A. H., & Axelrod, R. (2013). *The dissemination of culture Model*. NetLogo user community models. http://ccl.northwestern.edu/netlogo/models/community/Axelrod_Cultural_Dissemination.

was thoughtfully designed, correctly implemented, thoroughly tested, well understood, and appropriately used for its intended purpose.

The rationale of this document follows:

> Schmolke A, Thorbek P, DeAngelis DL, Grimm V. 2010. Ecological modelling supporting environmental decision making: a strategy for the future. Trends in Ecology and Evolution 25: 479-486.

and uses the updated standard terminology and document structure in:

> Grimm V, Augusiak J, Focks A, Frank B, Gabsi F, Johnston ASA, Kułakowska K, Liu C, Martin BT, Meli M, Radchuk V, Schmolke A, Thorbek P, Railsback SF. 2014. Towards better modelling and decision support: documenting model development, testing, and analysis using TRACE. Ecological Modelling

and

> Augusiak J, Van den Brink PJ, Grimm V. 2014. Merging validation and evaluation of ecological models to 'evaludation': a review of terminology and a practical approach. Ecological Modelling.

If this document includes **hyperlinks**, navigation back and forth along previously chosen links works via "ALT" + "←" or "ALT" + "→".

Contents

<*Do not edit this table of contents or the headings of the eight TRACE elements. Update page numbers of this TOC by right-clicking on it and choosing "update fields". If your TRACE document is long and complex, you might want to add sub-headings; please use existing styles for this, e.g. Heading 2 in Microsoft Word. You can specify how many heading levels the TOC includes.*>

1 Problem formulation

This TRACE element provides supporting information on: The decision-making context in which the model will be used; the types of model clients or stakeholders addressed; a precise specification of the question(s) that should be answered with the model, including a specification of necessary model outputs; and a statement of the domain of applicability of the model, including the extent of acceptable extrapolations.

Summary:

Politicians would benefit from being knowledgeable of certain trends that are happening in their political party. A politicians' main goal is to win the elections; therefore, they should be aware of trends that are happening in and out of their political party. Election time is a very hectic and emotional time. It's a time when people can get very stressed, tired, and even frightened. Naturally, people are going to migrate and move around to places where they feel more comfortable. This model will show the trend of how people move around to be

surrounded by people who make them feel comfortable. This model will show how the trend changes during election time as well.

The political party model is based on the Segregation model created by Thomas Schelling. Thomas Schelling's segregation model is a good representation of the patterns that can occur in society based on the decisions that individuals make about where they want to live and the type of people that they want to live around them. The segregation model consists of two different types of agents, orange and blue. Every individual agent wants to find a place to live. Every agent also wants to be happy in the place where they reside. The only way that the agents will be happy is if they are around people who look like them. In the political party model, there is a slider to adjust the percent of similar agents that they want around them. If the slider is on the lower end, the agents don't care as much about being around other agents that look like them. If the slider has a higher percentage, they will feel comfortable having more agents around that look like them.

It is very natural for individuals to segregate themselves to feel comfort. Schelling mentioned that individuals segregate themselves in most areas of their life. People tend to go to church, school and work with individuals who share similar characteristics to them. The thing to note about this model is that the agents aren't gathering to plan and decide to all live together or separately. Each agent makes an individual decision about where it feels comfortable living. However, when the agents have a preference for a higher percentage of agents around them that look like them, we see clusters begin to form. It looks as if all the orange agents planned to live with each other and all the blue agents decided to live together. Here we see an example of how several individual's discriminatory decisions can create segregation in a larger collective (Schelling 1978).

For a politician and other people who are involved with the government and political parties, one most important days of the year is Election Day. In the few weeks before Election Day, the country started to divide. Everyone has their focus on the election. This causes an immense amount of stress to these individuals. Stress is something that can affect every aspect of your life. If someone is stressed, that stress will also affect their decision making. During an election, if tensions are already high and someone is stressed, they will choose to be around people that will make the stress go away. Individuals might find that they are less stressed by being around those that are similar to them. If they are already stressed, they don't want to be around people who will increase that stress for them (Majumder et al., 2017).

The political party model will answer the following research questions; "How do the agents behave when they are around people who are in a different political party than they are?", "Based on the agent's preference of the percentage of similar people around them, when do clusters begin to form?", and "How do the agents behave differently during election time?"

2 Model description

This TRACE element provides supporting information on: The model. Provide a detailed written model description. For individual/agent-based and other simulation models, the ODD protocol is recommended as standard format. For complex submodels it should include concise explanations of the underlying rationale. Model users should learn what the model is, how it works, and what guided its design.

Summary:

The political party model is based on Schelling's segregation model. The extensions that have been added to the model show how the agents react when there are three different types of agents, rather than the two types of agents that were in Schelling's model. The other extension that has been added is the election time period in the model. During this time period, the user can see how the agents behave differently than they would if it were not election time.

1.Purpose

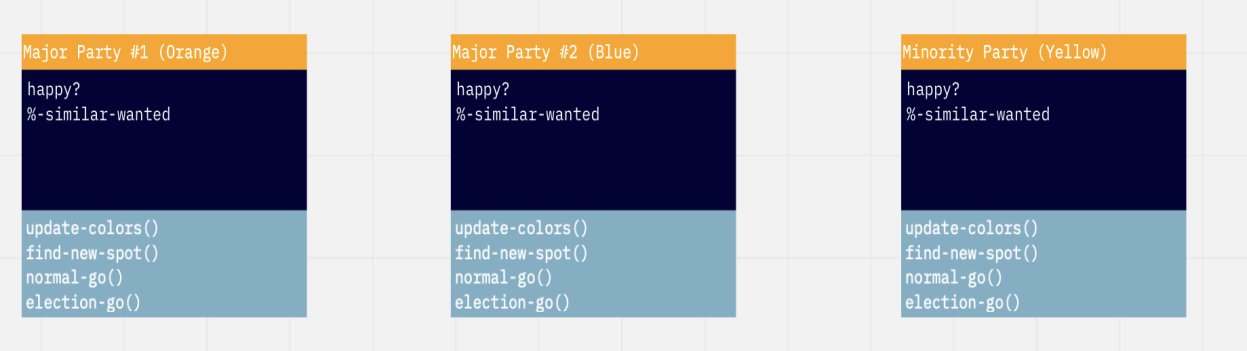
The political party model aims to show the trends that occur in political parties based on how much they want to be surrounded by people who share the same beliefs as they do. There will be an election time period during the model run that will show the changes that happen to the trend during a high stress time period such as the weeks leading to the big Election Day. This model is a tool to help government officials see how the different political parties will react to each other. They can use this model to try to determine the point where the different parties begin to clump together (during election time and outside of the election time period). This model is implemented in Netlogo.

Below, I have created a chart to show the observations collected at each time tick. Major party #1 are the turtles that are randomly selected from the major density with a color of 105. Major party #2 are the turtles that are randomly selected from the major density with a color of 27.

Outside of Election Time Period (Ticks: 1-20, 25-45, 50-70)	
Name of observation collected at each tick	**Description of each**
similar-nearby	**How many neighboring patches have a turtle with my color?**
other-nearby	**How many have a turtle of another color?**
total-nearby	**Sum of similar-nearby and other-nearby**
yellow-nearby	**The amount of neighbors surrounding the agent that is in the minority party (minor-density)**
orange-nearby	**The amount of neighbors surrounding the agent that is in the major party #1**
blue-nearby	**The amount of neighbors surrounding the agent that is in the major party #2**
During Election Time Period (Ticks: 20-25, 45-50)	
Name of observation collected at each tick	**Description of each**
similar-nearby-election	**During the election time period, How many neighboring patches have a turtle with my color?**
other-nearby-election	**During the election time period, How many have a turtle of another color?**
total-nearby-election	**During the election time period, Sum of similar-nearby-election and other-nearby-election**
yellow-nearby	**The amount of neighbors surrounding the agent that is in the minority party (minor-density)**
orange-nearby	**The amount of neighbors surrounding the agent that is in the major party #1**
blue-nearby	**The amount of neighbors surrounding the agent that is in the major party #2**

2.Entities, State variables, Scales

The entity is the agent. There are blue, orange, and yellow agents that each represent a person who is affiliated with a specific political party. The number of agents on the grid are determined by the density. The user can change the density percent which regulates the initial number of agents on the grid. During each tick, the agent needs to decide if it is happy with its surrounding neighbors. The agent will be happy if the value of the "%-similar-wanted" is equal to or greater than the percentage of agents that are around them of the same political party (color). If it is not happy, it will find a new spot to go to which is usually the closest empty patch to them. (See the class diagram below for a visual of what is described above.)

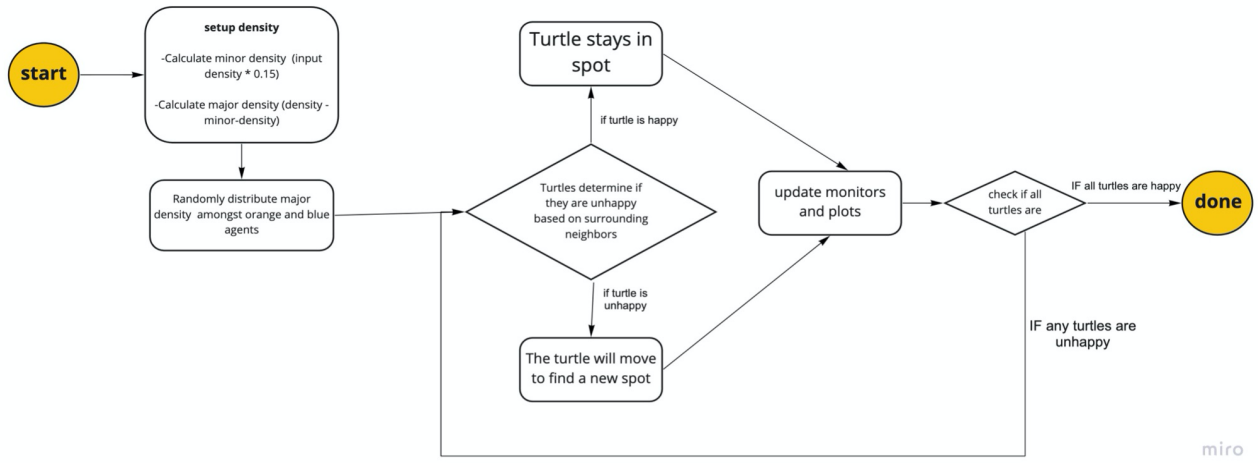


3.Process overview and scheduling

In every time step (ticks)

- Agents calculate their preferred percentage of agents that surround them who share their same political party.
- The turtle determines if they are happy based on the agents who are around them and their preference of similar agents around them.
- If the turtle isn't happy, it will move to the closest empty spot.

The turtles keep moving through every tick until they are all happy. If a turtle is happy, this means it has been surrounded by their preferred percentage of agents that share the same political party as they do.



4. Design Concept

Basic Principles

- The basic principles for this model are developed in a book titled, 'Micromotives and Macrobehavior" in chapter 4, Sorting and Mixing: Race and Sex. This book explains that there are two main processes of segregation. These processes are organized action and individual motivation (Schelling 1978).
- Organized Action

  Organized segregation is the intentional separation of groups of people. A good example of organized action is housing segregation in America today. Different ethnic groups never intentionally planned to live separated from each other. There is a long history to why these neighborhoods are separate. In the early 1900s, there was a strong effort to segregate residential communities. Some cities adopted zoning laws that would discourage minority families from moving to predominantly white places of living. In the Buchanan v. Warley case, the Supreme Court declared that such zoning was unconstitutional. Secretary of Commerce, Herbert Hoover, wanted to get around this ruling. Therefore, he created a group of people that helped create laws that targeted the black community. This committee passed rules that made it unlawful for low-income families to move into middle-income neighborhoods (Magazine 2017).
- Individual Motivation

  In terms of individual decision dynamics, several segregation problems may be similarly tough. People tend to make decisions because it would be better for their lifestyles. People are naturally selfish and don't always think of the effects of how their individual actions may affect the world as a whole. Therefore, they switch neighborhoods, churches, worksites, and school just because the individual might feel more comfortable in a different setting surrounded by different people.
- Tolerance is an important part of the model. Every person has their own tolerance. The tolerance in the model is described as the "%-similar-wanted". The user chooses the level of

tolerance with a slider. When a person selects a value on the "%-similar-wanted" slider, they are stating that if they are surrounded by less than X% of agents that are in the same political party that they are in, they will be unhappy and leave that patch (Schelling 1978).

Learning

- Agents learn from their comfort level of the percentage of people surrounding them who are similar to them. If they are around a percentage less than what they feel comfortable with, they learn to leave that area and find a new open spot.

Prediction

- Agents predict that when they move, they will be in a place where they feel more comfortable living. If they are happy on the patch that they are on, then they predict that they won't have to move anymore because they are around people who feel comfortable being around them as well. If everyone stays in the same place, then they will always be happy.

Sensing

- Agents are able to see the political party of the other agents. The agent decides to leave based on their examination of the percentage of people surrounding them of the same political party.

Interaction

- In every time tick, the agents determine the percentage of similar agents that are surrounding them. The diagram below shows how the agent examines the neighbors around them. The yellow squares show who the agents consider a surrounding neighbor.

5. Initialization

The start up procedure creates turtles on random patches. Once the turtles are created, the program reads the density value that the user has inputted into the program using the slider on the interface. The slider lets the user put in values from 50% to 99%. Once the density value is read by the program, it will then create the minor density and major density.

Once the model is set-up, it generates the initial values for the following; "# agents", "% similar", "num-unhappy", "% unhappy", "# Yellow Agents", "# of Blue Agents", "# of Orange Agents". See the chart below to understand how these values are generated.

Value	**Command**	**How is it Generated?**
% similar	percent-similar	Total-nearby similar-nearby + other-nearby Total-neighbors sum [total-nearby] of turtles Similar-neighbors sum [similar-nearby] of turtles Percent-similar (similar-neighbors / total-neighbors) * 100
num-unhappy	count turtles with [not happy?]	The turtle does not have at least "%-similar-wanted" percent of that turtle's neighbors are the same color as the turtle
% unhappy	percent-unhappy	(count turtles with [not happy?]) / (count turtles) * 100
# Yellow Agents	count(turtles with [color = 47])	The minor density only takes 15% of what user input. The minor density sets the occupancy density for the yellow agents.
# of Blue Agents # of Orange Agents	count(turtles with [color = 105]) count(turtles with [color = 27])	The major density will represent the rest of the density that we didn't use in the minor density. The program randomly sets the occupancy density for the blue and orange agents using the major density and the "set color one-of" function.
# agents	count turtles	Total of: # Yellow Agents, # of Blue Agents, and # Orange Agents

6. Input Data

Agents' preferences have only one dimension which is the percent of agents surrounding them that is within the same political party.

This part of the trace document doesn't apply to our project.

Model input parameters:

1. density: slider to determine total grid density to be filled (filled spaces / total spaces)
    a. minor-density: density *0.15 to determine the density of the 3rd party
    b. major-density: blue-agent OR orange-agent grid density

c. Density - minor-density

2. %-similar-wanted: Percentage of like-colored neighbors that the turtle wants nearby to be happy
3. election-neighbors-wanted: number of neighbors wanted of a different color during election time to determine if the turtle will change to a new color and become happy

3 Data evaluation

This TRACE element provides supporting information on: The quality and sources of numerical and qualitative data used to parameterize the model, both directly and inversely via calibration, and of the observed patterns that were used to design the overall model structure. This critical evaluation will allow model users to assess the scope and the uncertainty of the data and knowledge on which the model is based.

Summary:

The political party model consists of a population of agents, each one occupying a single node of a square network. All the data is created within the model with randomization to each agent's attributes.

As mentioned in model description (section 2) from the ODD, the agents are randomly generated and there are no external data sources.

The major party turtles are created on random patches

```
if random 100 < majority-density [   ; set the occupancy density using only the majority of the density NEW
  sprout 1 [
    ; 105 is the color number for "blue"
    ; 27 is the color number for "orange"
    ; 47 is the color number for "yellow" NEW
    set color one-of [105 27]
    set size 1
  ]
]
```

The minor party turtles are created on random patches

```
; This creats a third party that has fewer agents in it than the other two parties. NEW
if random 100 < minor-density [   ; set the occupancy density using only the minority of the density NEW
  sprout 1 [
    ; 47 is the color number for "yellow" NEW
    set color one-of [47]
    set size 1
  ]
]
```

4 Conceptual model evaluation

This TRACE element provides supporting information on: The simplifying assumptions underlying a model's design, both with regard to empirical knowledge and general, basic principles. This critical evaluation allows model users to understand that model design was not ad hoc but based on carefully scrutinized considerations.

Summary:

The political party model consists of a population of agents that is determined by the density slider. All the data is created within the model with randomization to each agent's attributes. The extension that we added was the use of the third part agent, yellow agents, and the election time tick period.

Minority Party Agents

We needed to implement the third party because, in the United States, they have played a huge role in bringing about social, cultural, and political reform (Longley 2021). Some of the most active third parties in the presidential elections are the libertarian party, socialist party, reform party, Green Party, and constitution party (Longley 2021). Libertarians think that the federal government should have only a little role in everyday living. They think that the government's only proper purpose is to protect citizens against acts of physical threats. Members of the Reform Party are committed to changing the policies in the government. Oftentimes, they want to work to change the entire system. They favor candidates who they believe that the government will benefit them with strong ethics and budgetary responsibility (Longley 2021). "Greens seek to restore balance through recognizing that our planet and all of life are unique aspects of an integrated whole, and also through affirming the significant inherent values and contribution of each part of that whole," (Dixon 2020). The Constitution Party advocates for a government system based on the United States Constitution and the principles of the founding fathers'. They tend to be very strict with how they read and understand the constitution. They advocate for a government with limited structure and power. The Constitution Party supports the restoration of giving governmental power back to the people (Longley 2021). The third party is always a much smaller political party than both the democrats and republicans; therefore, we created the code to let the minority party be 15% of the density.

Election Time Period

The election time period occurs during certain time ticks. These time ticks include; 20-25 and 45-50. During election time, the people all over the country tend to be more stressed out. During times of stress, some people may feel more compelled to be around people who are similar to them. People will do anything to illuminate stress to their lives, especially during election time. In a study conducted in February of 2017, the APA reported that "57% of American adults felt that the current political climate was a considerable (i.e. very or somewhat significant) source of stress, indicating that the effects of the

2016 Election on the mental health and well-being of the US population had not subsided considerably following the election," (Majumder et al., 2017).

In the model, the agents increase their percentage of wanting to be around people that are like them. This is determined by the election slider. The user decides the value for the number of similar neighbors (out of 8) the agents would prefer surrounding them during the election time. During election time, agents will most likely want to be surrounded by more agents of their own party. This might look different outside of election time.

5 Implementation verification

This TRACE element provides supporting information on: (1) whether the computer code implementing the model has been thoroughly tested for programming errors, (2) whether the implemented model performs as indicated by the model description, and (3) how the software has been designed and documented to provide necessary usability tools (interfaces, automation of experiments, etc.) and to facilitate future installation, modification, and maintenance.

Summary:

The political party model has been checked for implementation verification by running the code as often as we can and running examinations on the input and the output. There are no problems, and everything runs smoothly. The model should be able to be modified.

This program was built in NetLogo and has no issues. The original developer has left comments in the code that make it easier to make changes and adjustments to the model for future projects and research. In the political party extension that we have added, we have created comments that explicitly state which part of the code is newly added. Any data scientist or government official will easily be able to adjust the code because the comments guide the user to fully understand what each part of the code is supposed to do. Whether the user wants to change values on the slider or change values in the code, it should be a relatively easy process. The political party model will be a useful tool in understanding the trend and pattern of how people move around based on being comfortable with those around them during the election time period and outside of the election time period.

6 Model output verification

This TRACE element provides supporting information on: (1) how well model output matches observations and (2) how much calibration and effects of environmental drivers were involved in obtaining good fits of model output and data.

Summary:

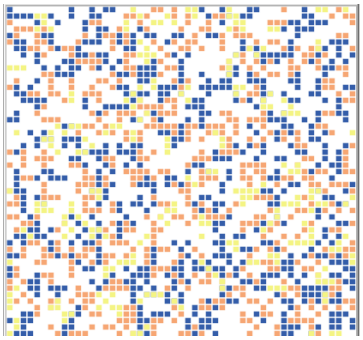
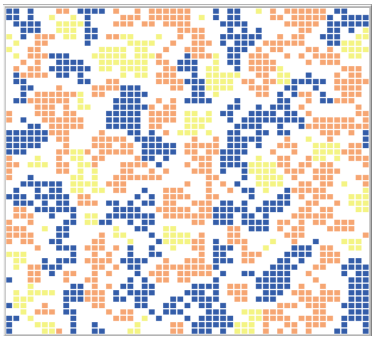
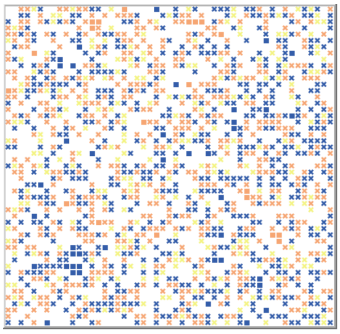
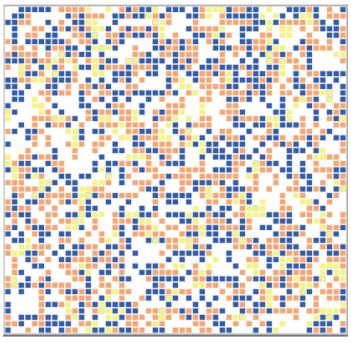
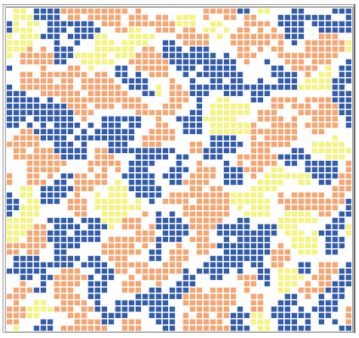
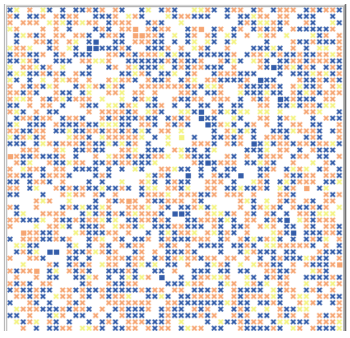
Since we did not create this model from scratch, this code has already gone through a calibration process. The model including agent behavior and sliders interact as they are supposed to. This section does not apply to our team.

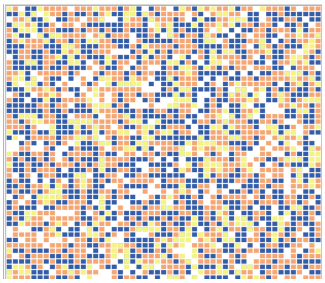
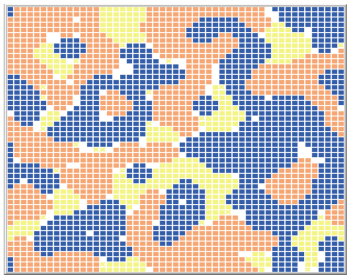
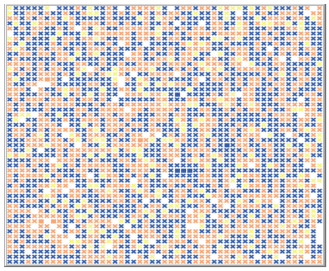
7 Model analysis

This TRACE element provides supporting information on: (1) how sensitive model output is to changes in model parameters (sensitivity analysis), and (2) how well the emergence of model output has been understood.

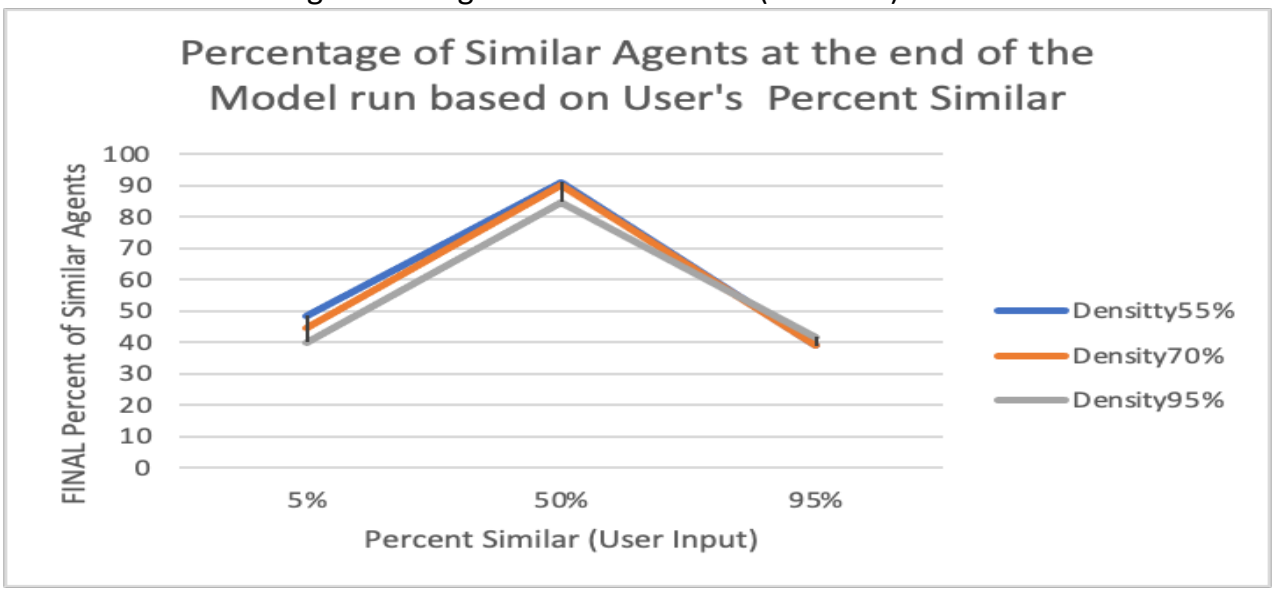
Summary:

The biggest change in the model occurs when the density and "%-similar-wanted" sliders are changed. We analyzed the lowest to highest values for "%-similar-wanted" with the lowest to highest density. Below, we record the final outcomes of the percentage of similar turtles and the unhappy turtles. The plots show the change in the final outcomes of the percentage of similar turtles and the unhappy turtles as the "%-similar-wanted" increases (for the highest, middle, and lowest densities).

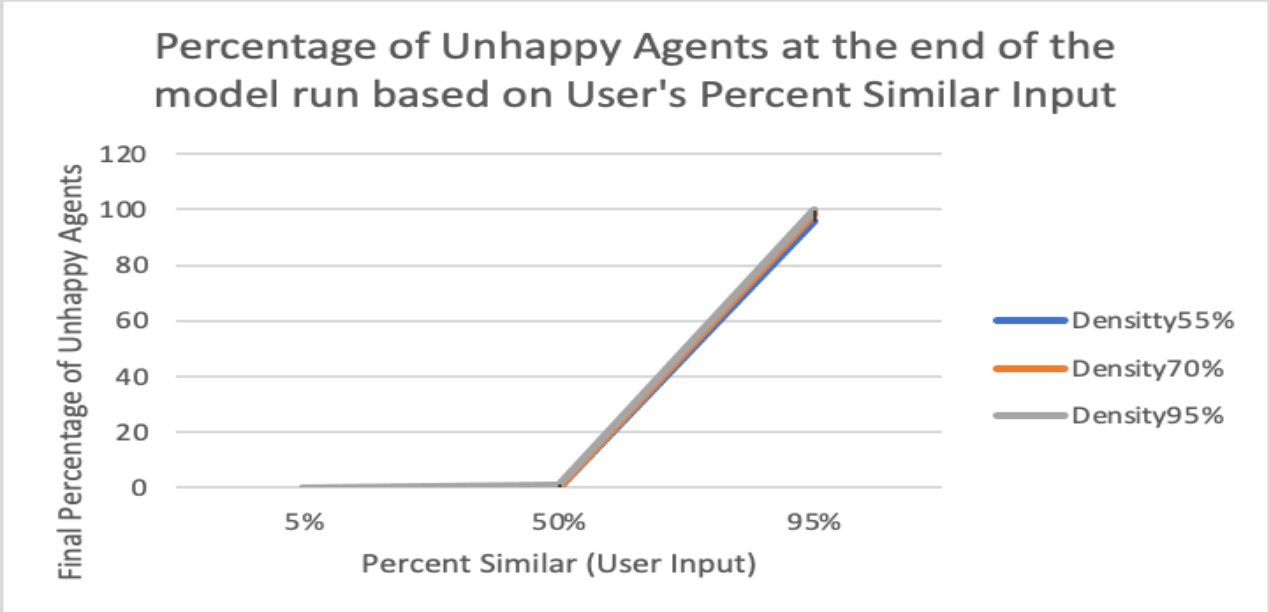
Density **55%**	Similar 5%  FINAL Similar Turtles: 48.6% FINAL Unhappy Turtles: 0%	Similar 50%  FINAL Similar Turtles: 91% FINAL Unhappy Turtles: 0%	Similar 95%  FINAL Similar Turtles: 38.9% FINAL Unhappy Turtles: 95.8%
Density **70%**	Similar 5%  FINAL Similar Turtles: 44.5% FINAL Unhappy Turtles: 0 %	Similar 50%  FINAL Similar Turtles: 90% FINAL Unhappy Turtles: 0%	Similar 95%  FINAL Similar Turtles: 39.2% FINAL Unhappy Turtles: 98.3 %
Density	Similar 5%	Similar 50%	Similar 95%

95%	 FINAL Similar Turtles: 40.1% FINAL Unhappy Turtles: 0%	 FINAL Similar Turtles: 84.8% FINAL Unhappy Turtles: 1%	 FINAL Similar Turtles: 41.7% FINAL Unhappy Turtles: 99.8%

Plotting the Change as Percent Similar (on slider) Increases



Plotting the Change as Percent Similar (on slider) Increases



8 Model output corroboration

This TRACE element provides supporting information on: How model predictions compare to independent data and patterns that were not used, and preferably not even known, while the model was developed, parameterized, and verified. By documenting model output corroboration, model users learn about evidence which, in addition to model output verification, indicates that the model is structurally realistic so that its predictions can be trusted to some degree.

Summary:

This section does not apply to our group.

References

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