| ODD of Dynamics of the spread of Tuberculosis in South Carolina | | |
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| Overview | Purpose | The purpose of this model is to replicate the dynamic of the spread of Tuberculosis in the state of South Carolina. |
| | Entities | The main entities included in this model are people. In addition, the environment is also an entity in this model. |
| | State Variables | Each agent (person) in the model is characterized by their age and the state of their health (i.e. if they are healthy, have a weakened immune system due to HIV/Cancer, have latent tuberculosis, or have active tuberculosis).<br><br>Each cell in the environment is characterized by their state of either being clear or contaminated with infectious droplets of tuberculosis. The state of the cells depend on whether or not an agent with active tuberculosis coughs wich would make the cell contaminated. |
| | Scales | The spatial scale of this model is within the state of South Carolina. In addition, the world is comprised as 200 by 200 patches each patch with a patch size of 2.<br><br>For the temporal scale, one tick in the model is considered to be 5 days. |

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| | Process Overview | Each tick is considered to be 5 days. |
| | Scheduling | For each tick, it checks if a year has passed or not. If a year has passed all the agents will age by 1 year and the model assumes that an agent equal to or older than 95 years old will die. These deaths are not analyzed since the model seeks to see the spread and impact of tuberculosis. If a year has not passed, the agents do not age by 1 year.<br><br>Then if the turtle has active tuberculosis, there is about a 15% chance that the agent will cough. If it does not cough nothing happens, if they cough they contaminate the air with tuberculosis and agents in the contaminated air are at risk of becoming infected. Then the model will check if it has been a year since an agent has lived with active tuberculosis. If it has been a year then about 50% of the agents with active tuberculosis will die from having tuberculosis.<br><br>Then all agents that are not dead will move in a random direction. After they move, agents that are healthy, have latent tuberculosis, or a weakened immune system will see if they are in contaminated air or not. If they are they will try to avoid |

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| | | that air by moving away by a certain amount. Agents with a weak immune system will try avoid the contaminated air by moving farther away than an agent that is healthy or latent tuberculosis. If the air is not contaminated the agents don't move again until the next tick.<br><br>Then, the model will check to see if the agent is still in a contaminated area or not. If it is there is about a 10% probability that a healthy agent gets infected and develops latent tuberculosis and there is about at 55% chance that an agent with a weak immune system develops active tuberculosis. If the states of the agents changes then the turtles are rendered to update to the new color that is corresponded to the state they have become. This allows for better distinction and visualization in the model.<br><br>Then the model will clear up the air that is contaminated with tuberculosis. Just like the turtles, the patches will be rendered to the color that corresponds to the state they have become (clear of tb contamination).<br><br>To simulate that births will affect the population, 10 new agents are created and about 7 are healthy and 3 have a weak |

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| | | immune system. These new agents are then rendered to also become a part of the model.<br><br>This is what is simulated in 1 tick. Since one tick is considered 5 days. After 730 ticks it is considered to be 10 years which is where the model is stopped. Although the model can be run for longer than 730 ticks. The only reasoning is that when the model continues to run, it takes longer to compute 1 tick due to the increase in the number of turtles that the model has to assign states and run calculations on. |
| Design Concepts | Emergence | From this model, it suggested an emergence that when agents with active tuberculosis randomly cluster in certain areas, there was a higher concentration of agents that would then developed either latent tuberculosis if an agent was previously healthy and active tuberculosis if an agent has a weakened immune system. A possible explanation for this is that the not yet infected agents could not avoid the contaminated air as much as if the agents with active tuberculosis did not cluster |
| | Adaption/Adaptive Traits | The environmental states that the agents consider when they move is if the air is contaminated from the cough of a person that has active |

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| | | tuberculosis. If the air is contaminated, the agent will try adapt and try to avoid the contaminated area to reduce the risk of becoming infected with tuberculosis. Those agents that have a weaker immune system will try to avoid the contaminated air near the active tuberculosis agent more than those that are healthy or have latent tuberculosis but not know they have tb. |
| | Objectives | The objective of the agents that are healthy is to remain healthy. In other words, a healthy agent will try not to become infected with tuberculosis. This is also the same for agents that have a weakened immune system. The only difference is that those with the weaker immune system can get infected more easily than if an agent was fully healthy. |
| | Learning | The agents in this model do not have learning. The do not change their behavior due to consequences or from experiences from the past. |
| | Prediction | In this model the agents do not use learning or memory from the past to predict possible future outcomes. |
| | Sensing | There was not a great deal of sensing exhibited by the agents. Although the agents would try to avoid a contaminated area if in the |

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| | | contaminated area however it could not sense if the contaminated area was nearby and avoid that area entirely. |
| | Interaction | There is not direct interaction between the agents. There is an interaction between the agents and the environment where the action of coughing from an agent with active tuberculosis will cause agents that are healthy, have latent tuberculosis, and agents with a weakened immune system to try to avoid the patches that are contaminated in an attempt to keep from getting exposed to tuberculosis. For that reason, there could be an indirect interaction between the agents: the action of coughing from one type of agents will result in a reaction from agents of other states. |
| | Stochasticity | There is some stochasticity in the model. The direction that an agent will move is randomly generated to simplify the movement of people when they go about their daily life and come in close contact to one another (such as run errands). In addition, there is randomness involved in the probability than a person with active tuberculosis will cough and contaminate the air with droplets of tuberculosis. This is to help model that when a person coughs it is seemingly at random times yet would be |

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| | | more common with those that have the active tuberculosis. |
| | Collectives | Collectives are not represented in this model. |
| | Observation | The numbers and proportions of each of the different states were used to observe and compare to data collected to validate the accuracy of the model. |
| Details | Initialization | To setup the model, the data was loaded and used to initialize the proportion of agents that would be healthy, have a weak immune system, have latent tuberculosis, or active tuberculosis. Once the states were determined for the turtles, they were rendered to different colors to be able to distinguish them better when the model is run. The patches were all given the state of being clear of droplets of air contaminated with tuberculosis. Just like the turtles, the patches were rendered for clarity when the model is run. The ages were then setup for the turtles. Each turtle is assigned a different age ( young is from ages < 21, adults are from ages > 22 and < 64, and elderly are > 64. |
| | Input Data | At t = 0<br>- The initial population proportions are loaded into the model.<br>- all the patches are given the state that |

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| | | they are clear of tuberculosis contamination and rendered to clarify in the visualization.<br>- Then 1000 turtles are created. About 820 turtles are healthy, about 130 have a weakened immune system, about 40 have latent tuberculosis, and about 10 turtles have active tuberculosis.<br>- Each turtle is then rendered to a color corresponding to each state for clarity of visualization.<br>- Then the ages are set up for each turtle.<br>- There is a 27% chance they will be in the young age range, a 15% chance an agent will have an age within the elderly age range, and a 58% chance an agent will be in the adult age range.<br>- Then an age within the range they are randomly placed is randomly assigned. |
| | Submodels | - Age<br>As people age and become elderly, it is possible for them to develop active tuberculosis since with age their immune system is said to weaken and become more vulnerable to |

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| | | infection and/or less resistant to fighting or suppressing infections.<br><br>- Weakened Immune System<br><br>Since those with a weakened immune system have a higher possibility of becoming infected with tuberculosis, this was included in the model as it would affect the outcome of the spread of tuberculosis.<br><br>The probabilities of infection for both were assumed in an educated guess and to also be significant enough that the spread of tuberculosis could be simulated. There was also some liberty taken to simplify that if an agent had a weakened immune system, and they were exposed to tuberculosis they would develop active tuberculosis. there was no proportion of them that could develop latent tuberculosis. For agents that were healthy they could only develop latent tuberculosis if they were infected. The model did not account that a proportion of healthy agents that were infected could immediately develop active tuberculosis without first having latent tuberculosis. |