**Unit 4 – Solving Complex Problems**

**\*\*Instructions:** Please change the text color of your responses to red text. Please organize the endings to each page.

**ACTIVITY 4.1.2 – Simulations to Predict Growth Rates**

**GOALS:**

* Use models and simulations to find trends in data.
* Differentiate between correlation and causation.
* Identify bias while deriving meaning from a simulation.
* Compare a simulated event with a real-world event.

You will be using NetLogo for this assignment. Please make sure that you have it installed on your laptop.   
  
Complete the following:

Step 3: Record the value of the Num Turtles reporter in the table as you step through the simulation using the go once button.

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| Iteration Num | Num Turtles |
| Setup (1) | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 8 |
| 5 | 16 |
| 6 | 32 |
| 7 | 64 |

Step 7: Explore how color is managed in NetLogo because it is an important part of this model. Select **Tools > Color Swatches** to see NetLogo's color names and values.  If you were to set **color-inc** to **0** and **init-color** to **55**, what color(s) will be used to render the tree?

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| The tree would be rendered with an olive green and never change color, as the color increment is 0. |

Step 8: If you were to set **color-inc** to 1**0** and **init-color** to **50**, what color(s) will be used to render the tree?

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| The tree would be initially rendered in black, and never change color because 60 is also black, 70 is also black, etc. |

Step 9: Keep **color-inc set**to 10 and change **init-color** to **105**. What are the colors of the tree.

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| The color starts out as indigo, but becomes purple, pink, gray, red, orange, and moves through the rest of the colors of the rainbow. |

Step 12: What if you wanted to create a fractal with many different shades of the same color? Create this pattern.

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| I would set init-color to a multiple of 10, and set init-color to 1, and then use a modulo operator to keep the color below 10 more than the original init-color. |

Step 18: Modify the model so that one simulation parameter, the length of time a person stays immune, is part of the interface. What parameter did you add or remove to make this simulation work correctly?

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| I removed the immunity-weeks (originally immunity-duration) variable from the globals list, as it has to be read from the slider instead. |

With a highly infectious disease that has little chance of recovery, will a larger population spread the disease and make it worse or will it mean a faster elimination of the virus? Use the simulation to justify your prediction. Describe your conclusion and how you used the simulation to justify it.

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| A highly infectious disease with little chance of recovery will be worse with a larger population. I tested this by running the simulation with a 90% infectiousness and a 10% chance of recovery with 150 people, where the disease spread to most of the population but then quickly disappeared, causing the population to drop to 80, and then running the same simulation with 300 people, which caused the population to drop down to 55 people from deaths, after which the disease disappeared. The larger population decrease in the larger population shows that a larger population makes highly infectious diseases worse. |

Step 22: Describe the different states of the nodes in the network. Use the HOW IT WORKS description on the **Info** page to help you answer this question.

1. What do you think a red node indicates?

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| A red node indicates a computer infected with a virus or worm. |

1. What does gray indicate for both the node and its links?

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| A gray node/link means that that area cannot be infected by the virus or worm. |

1. When a node alternates between blue and red, what does it represent?

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| The node is constantly being infected by the virus/worm and being repaired by the user, without the user implementing changes to protect against future attacks. |

Step 23: Eventually, this simulation will automatically stop. Observe the world and the Network Status plot to describe the state of the model when this occurs.

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| All nodes become blue or gray, with no infected computers left. |

Step 24: Run the simulation without **view updates** at least five times. What is the fastest and slowest rate of virus eradication (when the virus is gone from the network)?

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| Results (sorted): 857 1283 1494 1545 1625  The fastest rate of eradication was 857 ticks, while the slowest was 1625 ticks. |

Step 25: Keeping other parameters at their default value, increase the **number-of-nodes** to 300. Does this affect the rate of growth? Why or why not?

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| Increasing the number of nodes increases the rate of growth, as there are more ways for the virus to travel. |

Step 30: Observe the effect of a real-life virus called Code Red that began at midnight on July 19, 2001. Search internet images for **“code red virus” graph**. The quotation marks will help you narrow your search results. Using the data visualizations in your search results, how fast did the virus spread and then how long did it take to become (mostly) eradicated? How does your simulated virus spread to reflect the real-world spread?

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| The virus spread exponentially in a period of less than 4 hours, but then died down in a period of 8 hours. The simulated virus spread in a similar timespan, taking twice the amount of time to die down than to initially spread, but also had a lower impact, not having the same exponential growth as the code red virus. |

Conclusion: How can simulations be used to predict growth?

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| Simulations can be used to predict growth by making models that closely match real life, either through historical examples or current statistics. To make accurate predictions, they must be precisely modified, but can usually still display overall trends if not extremely accurately modeled. |