CX4230 - Computer Simulation
Project 3 - Zika Virus Propagation - Checkpoint F
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Implementation Plan Status - Checkpoint F - Update:

- We might add a possible fun fact about the US network flights and nodes to see how close it mimics the power law or if there is one that it follows it, if we have time. **- We did implement. Follows an alpha of 1.**
- General clean up on zikaSim.py file to account for protecting against bad data entry - **Completed**
- Final Poster complete - **Done, unless the professor has comments.**
- Print out poster by Monday, May 2 - **Yes, we are printing out on Monday**

Implementation Plan Status - Checkpoint E:

- Change infection rates (something other than a TAU of 4) for different diseases and seeing the differences - Implemented with a new parameter allowing the user to change to different TAUs for different diseases.
- Change start of infection and seeing effects - Implemented code to start infection at every city during every month to find worst case parameters. Based on output, multiple cities seemed to be bad, so we just used ATL as the starting airpot for the month of June.
- Add and change vaccination rates based on delay of how many people get vaccinated - Implemented with the concept that vaccination would be a preventative measure only. Not a reactive measure.
- Shutdown the starting hub at different days (1-9) and see the effect - Accounted for in screening effect
- Maybe graph the shutdown to observe which one is more critical - Accounted for in screening effect
- Add visualization by adding several map for the modeled system. White, yellow, orange, red, etc. - Implemented
- Could be interesting to look at different time frames for stopping flights out of ATL or another hub - Implemented a screening method prevent sick passengers from traveling
- Poster suggestions from Jordi
    - Lots of pictures - Created
    - Most important stuff - back to point a - more pictures - Created
    - How we extended the model - Discussed

  - ➢ Conclusion - Discussed

- ❖ Maybe not get into networks properties - edge cut reduced, maybe not worth exploring at this small of a network - Jordi - No network properties were looked at in detail due to small network.
- ❖ Final network ~~and agent-based~~ model complete - Implemented
- ❖ Final analysis complete - Completed
- ❖ 1 page summary complete - see this document
- ❖ Draft Poster complete - Completed

<u>Implementation Plan Status - Checkpoint D - From Checkpoint D:</u>

- ❖ Road network and agent based portion was taken out by Checkpoint D as the datasets are growing too large, the agent based would be too complex at the local level, and the road network as of right now would not add any value to the overall design.
- ❖ The mosquito biting and infection dynamics will be rolled up into the “Ro” reproduction number for the spread of a disease. This was approximated at a value of 4 recently by this paper http://www.travelmedicinejournal.com/article/S1477-8939(16)30008-4/fulltext and as reported here http://www.npr.org/sections/goatsandsoda/2016/04/15/473976155/how-contagious-is-zika .
- ❖ The mosquito abundance in the environment will be determined based on the curves estimated from Figure 2 - the Ensemble model presented here http://currents.plos.org/outbreaks/article/on-the-seasonal-occurrence-and-abundance-of-the-zika-virus-vector-mosquito-aedes-aegypti-in-the-contiguous-united-states/#ref58 .
- ❖ With the mosquito and zika virus dynamics from above, ODE equations were solved for all of the infection, susceptible, and recovered humans at each hub. Vaccination will be added for Checkpoint E.
- ❖ Implemented the transfer of the infection via airplane routes
- ❖ Draft network and agent-based model complete - network has been implemented. No agent-based model will be implemented as the computational complexity of managing individual humans or mosquitoes is too great for this size project.

- Added visualization for the SIR curves. Can be changed to show the I curve for all the hubs.
- Added a map visual to show the flights from one hub to another - basically all the connections are shown on a geographical map of the US.
- Added parameters to start the infection at any given time (day) so we could analyze how different days of different months impact the propagation of the virus. Also added parameters for the range for the infection in order for us to better visualize the data in a concise way.
- Added parameter to start the propagation of the virus from any city based on IATA code to see which city had the greatest impact on spreading the virus.
- 1 page summary complete - See this document

Original Checkpoint C - From Checkpoint D:

- Obtain updated airport dataset for major airports in the US - **[No Changes]**
  - The OpenFlights.org original dataset will be used for the dataset. This will be trimmed down to just the airports within the seasonal boundary for the mosquitoes that can carry the Zika virus.
- Obtain top 25 hubs (cities) for analysis - **[No Changes]**
  - The top 25 cities that were within the seasonal boundary for mosquitoes that can carry the Zika virus were obtained from Wikipedia ("List of the busiest airports in the United States").
- Obtain number of flights and passengers per route - **[Changed - See strikethroughs below]**
  - Data was obtained from United States Department of Transportation - Bureau of Transportation Statistics and will have to combined to find statistics across all routes that are important to the airports within the seasonal boundary. ~~Its also possible that we may make it consistent with the road network data and assume some parameter or random number generation on determining how many people go by plane and road.~~

- Obtain interstate dataset for the US - **[Deleted - Couldn't find simple enough road dataset and road network wouldn't add much value to overall modeling experience as of right now]**
  - Based on what major airports are kept within the seasonal boundary of the mosquitoes, the road dataset will be created manually through the use Google Map distances on the interstates; basically creating a simple road dataset connecting the major hubs
- Obtain interstate travel data - **[Deleted]**
  - From the research we did, no data could be found for how many people travel per interstate, so we will make this a parameter on how many people travel and see its effect on the propagation of the Zika virus
- Obtain population data for all major cities in the US - **[No changes]**
  - Estimated Census data for 2014 was obtained from the United States Census Bureau
- Obtain seasonal boundaries for where mosquitos that can carry the Zika virus can live throughout the year, population data - **[No Changes]**
  - A pdf map was obtained from the Centers for Disease Control website. Unless an electronic boundary is found, the airports outside the boundary will have to be eliminate manually.
- Figure out mosquito reproduction dynamics - **[Changed - This will be rolled up into the "Ro" factor mentioned above]**
  - The life cycle of one species of mosquitoes is 8-10 days with the potential for each female to lay 100 eggs on each cycle based on data from the Centers for Disease Control
- Figure out all parameters that we need for varying modeling simulations - **[Changed - see below]**
  - Percentage of population that will travel by airplane~~ and road~~.
  - Parameter changing where the infection starts out based on the ranking of the most popular airports
  - Vaccination rate of the hubs
  - Ability to shutdown hubs
  - Infection rate synthetic curve

- Confirm graphic software to demonstrate model (NetworkX) - **[No Changes]**
    - Yes, we will be using NetworkX for this simulation