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ECE 220

James Scholars Project Report.

Pandemic Simulation.

**Introduction:**

For my James Scholars project, I decided to create a pandemic simulation. I decided to create this project because I wanted to dive into the process of how these models are create, how to manipulate data and how to make useful scenarios out of data. The way this project works in essence is I generate random people up to a million. Each person is defined by their age and this is what I use to determine the households they belong to, the workplaces they will go to everyday and the social group that they interact with. All these values for each person are generated at the beginning of the program and is based on the number of people and the age disparities that the user inputs. This program is separated into different functions which I will briefly summarize. I will also run some scenarios and provide the data in this document for each one.

**Functions:**

Generate\_People -> This function clears the data for every part of the struct that defines each person. It also initializes their age.

GenerateHousing -> This function associates’ different people with different households. Those who are under 18 are assigned a household with someone who is over 18 and can be associated with other siblings. Everyone over 18 can either be living in 1-4-bedroom houses. Each house has a safety factor that is randomly generated and is used in the calculation to determine the infection chance.

GenerateWork -> This function generates the different workplaces for each person. This under 4 are work with either a nanny or a parent. Those older than 4 and younger than 18 work in groups of 20 with other students along with a teacher. Those who are above this age work with people within the same age group in groups of 20. The safety factor for each workplace is also initialized here randomly.

Generate\_social -> This function generates the families for each person based on groups of random households. 3 groups of households makes a social group which also has its own safety factor.

Print\_Everyone -> Prints every person onto the terminal (Used for debugging)

Print\_People\_Div -> Prints some people onto the terminal. 10 groups of 10 people are printed.

Event\_Random\_Infection -> Sets a random person 18 years old or older to get randomly infected by the virus. This is the beginning of the pandemic.

Event\_Go\_To\_Work -> This is an event that occurs on every day. It counts the number of people who are infected in each workplace and infects other people in that workplace based on the R value, the safety factor and the number of people infected in that workplace.

Event\_Go\_Home -> Another event that occurs every day. It does the same thing as the Event Go To Work function but for the different households.

Count\_Infected -> Counts all the infected people on the day.

Prompt -> This function is used for the prompt that you see after every day. This is where you can set the testing and quarantine level, skip a week, exit the program or display some type of output to the terminal. You can also set an event called parties through the prompt.

Event\_See\_Family -> This is the social event that occurs, and each social group has a 20% chance of meeting every day. The method of determining new infections works the same way as the Home and Work event functions.

DayPasses -> This function occurs at the end of everyday and updates the number of days that a person has been infected. This is also where we determine if someone has recovered or died. The data I used to determine whether someone will die from the infection is provided later into the document.

Count\_Dead -> This function counts the number of dead people at a certain day.

Event\_Party -> This function groups 200 people from the age of 18 – 30 to gather into a party. The way the infection chance is determined is with the R value and the number of people who are infected. There is no safety factor for this one. Also quarantine rules don’t apply for these.

**Data Used:**

The R value for each disease in this program is arbitrary and that is why I have it input by the user in the beginning. Originally this program was meant for COVID-19 but later I worked on making it more general for any type of disease. The data I used for the death rates are from the CDC’s Website:

Values used:

Looking at Data from May 2020 to Aug 2020.

Source where I found the age disparity of cases within the United States (From May 2020 -> Aug 2020):

<https://www.cdc.gov/mmwr/volumes/69/wr/mm6939e1.htm>

Source where I found the age disparity of deaths within the United States (I added the numbers form May 2nd -> Aug 29th)

https://www.cdc.gov/nchs/nvss/vsrr/covid\_weekly/index.htm

Data I found:

Chance of Death given infected with COVID-19:

Ages 0->12: 0.06441%

Ages 13->17: 0.09581%

Ages 18->29: 0.09557%

Ages 30->49: 0.60765%

Ages 50->69: 4.13185%

Ages 70->100: 24.91779%

**Scenarios and Output:**

Here is where I will create different scenarios and compare the data. The output from the program is put into an Excel document where I turn everything into graphs. R value will be 1100 for all scenarios for consistent results. The age disparity is:

Child: 0 – 12, Teen: 13 – 17, Young adult: 18 – 29, Adult: 30 – 49, Senior: 50 – 69, Elderly: 70 – 99 respectively.

Scenario 1: City of 300,000 people. Age Disparity: 10%, 15%, 25%, 30%, 15%, 5%. The city heard of the pandemic and there was first contact from outside the city. There were already testing programs available from day 1. But only 1% of people were being tested daily. When someone tested positive, only the individual is quarantined. After 4 weeks they increased the testing to 5% and had those in the same household quarantine. After 4 weeks they increased the testing to 20% and everyone within the same workplace had to quarantine.

Total Infections: 47012

Total Deaths: 1011

Scenario 2: Same city of 300,000 people but the only thing that was done was having a 5% testing throughout most of the pandemic and only those in the same household had to quarantine. This testing was increased to 15% after 8 weeks. At day 130, 10 parties occurred around the city as cases started to go down.

Total Infections: 100731

Total Deaths: 2347

Scenario 3: Same city with 300,000 people but this time they invested in testing increasing it by 1% every day after 2 weeks. Those who tested positive had the whole household quarantined.

Total Infections: 17374

Total Deaths: 425

Scenario 3: Our school UIUC. We have the entire student population testing every week. So that would be roughly 20% testing every day. The age disparity for this school would probably be 5%,7%,45%,22%,16%,5%. When someone tests positive, the entire household is quarantined. About 10 parties happened on the third weekend of school. Population 60,000. I will let 3 weeks pass before school starts to account for the number of people who came in infected. After the parties I will say that everyone who works gets quarantined too to account for the measures put in place. I also increased the testing rate to 40%.

Total Infections: 4477

Total Deaths: 104

This scenario shows the limitations of how realistic my model could be as the randomness of it causes some scenarios to blow up while others don’t. This shows how important patient 0 is and those who get infected immediately after.

**Comparison Scenarios:**

I will run 4 tests with the same conditions.

200,000 people 10%, 10%, 20%, 20%, 20%, 20% age demographic. In each of these scenarios testing will begin at 2 weeks Starting at 5% only individuals will be quarantined. Then after 4 weeks it will increase to 50%. In each scenario the conditions will be different. Scenario 0 will be only individuals will be quarantined. Scenario 1 household will be quarantined as well. Scenario 2 workplace will be quarantined as well. Scenario 3 social group will be quarantined as well. Scenario 4 testing goes to 80% but only the individual must quarantine. R value will be 1200 for each case.

Scenario 0:

Total infections: 185548

Total Deaths: 13823

Scenario 1:

Total infections: 47478

Total Deaths: 3238

Scenario 2:

Total infections: 65159

Total Deaths: 4650

Scenario 3:

Total Infections: 46768

Total Deaths: 3210

Scenario 4:

Total Infections: 185338

Total Deaths: 13731

**Conclusion:**

The things that I’ve learned from creating these models is how random they could truly be and that can be reflected to how things really are. From the first few people who have a contagious disease it can spiral upwards to a pandemic that is worse off in one place more than another. Another thing I’ve learned was how important it is to act early. If I had put these quarantine rules in place from week 1 the number of infections would have gone down significantly. Assuming there is no outside interference, pandemics would end a lot sooner when action is taken early. Once there are many cases however, it becomes hard to bring down the curve once it has peaked. This program could contain more features like the fact that most students are doing online learning but for now I understand the concept of these models and the type of work it takes to create simulations.