OBJECT-ORIENTED PROGRAMMING FOR TRANSPORT ENGINEERS

EXAMINATION WS 2021/22

ASSIGNMENT 5:

**SIMPLE EPIDEMICS GRID WORLD**

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**Basic Variables of Models**

The variables used in all the models without exception are as follows:

1. Random Number Seed: Last digit of Matriculation ID (8).
2. Days in a year = 365.
3. Grid size = Last digit of Matriculation ID (8) + 10 = 18.

**Task 12.1**

Task 12(a) contains three models with Probabilities to Quarantine in case of infection 40% (Base Model), 50% and 100%.

**40% Quarantine Transition Probability (BASE MODEL)**

General Characteristics of Plot:

* X-axes represents days. One model represents one year.
* Y-axes represents:

1. Cumulative\_None = Cumulative count of Passenger tagged with infection status “None”.
2. Cumulative\_Infected = Cumulative count of Passenger tagged with infection status “Infected”.
3. Cumulative\_Quarantined = Cumulative count of Passenger tagged with infection status “Quarantined”.
4. Cumulative\_Recovered = Cumulative count of Passenger tagged with infection status “Recovered”.

* The year mentioned in the plot starts from 0. E.g. Year (0) is the first year.

**Description of the Base Model (1st Year):**

* The number of Passengers with no infection (Cumulative\_None) falls rapidly. Initiating with 440 uninfected, the **1st day** sees an **74%** new infection incident rate, lowering the number of uninfected to 144. The **2nd day** records **95.833%** new infection incident rate. On the 4th day we find no passenger with Infection Status “None”.
* The highest number of infections were recorded in the first 3 days in which, respectively 41.4%, 41.8% and 25.8% of the population were infected for the first time. Starting from the 5th day, the number of infected passengers started to fluctuate on regular intervals. Please note that, newly infected people can also move to Quarantine, therefore Cumulative\_Infected is not representative of all infected people, rather infected people who are still travelling.
* From the total 356 Infection incidents on day 1, 41.856% of passengers went into quarantine. The number of quarantined people increases each day, as in our code we provided opportunity for infected passengers to transition to quarantine at any time of their infection, but the transition will reset their total time under infection to 0. We did this because, suppose an infected passenger decides to quarantine on their 10th day of infection. Our code allows quarantined passengers to recover in 7 days (and infected passengers to recover in 14 days). This becomes a problem because the passenger now is in quarantine with infection days 10, and the moment he goes into quarantine he recovers, which is absurd. Nevertheless, the quarantine trend line trends to fluctuate and reach high values till the middle of the year and later falls on a periodic pattern.
* The trend line for recovered passengers follow the exact mirror form of the quarantine trend line, which makes sense since after 7 days of quarantine passengers recover.

**Model (2nd Year):**

This model of the 2nd year is the mere continuation of the previous year model.

* The quarantine and recovered trend lines appear to be denser in the middle of the year. The quarantine and recovered passenger numbers were fluctuating around the number which is half of the population.

**50% Quarantine Transition Probability (Model 2)**

This plot is for the Epidemic model with probability to transition to Quarantine 50%.

* The main difference with the previous model is the percentage of people going int quarantine. Within the 8th day 99.4% of population went into quarantine. Passengers stopped going into quarantine on the 22nd day.
* It is quite strange that, even though there is a probability to be infected when recovered (which is 3 times lower than normal probability), no one gets infected anymore from the 22nd day.
* The number of Passengers uninfected rapidly falls to 0 within the 4th day.

**100% Quarantine Transition Probability (Model 3)**

This plot is for the Epidemic model with probability to transition to Quarantine 100%.

* This plot depicts a very interesting scenario. When 100% population goes into quarantine, the number of uninfected passengers becomes constant after the drop on the 1st day. Obviously, on the 1st day the 60 previously infected passengers spread the infection, but a complete quarantine halted that spread immediately on the next day. As a result, according to the model, that specific infection was wiped out of the scenario on the 9th day (the last day of any passenger to quarantine).

**Task 12.2**

For these models we consider the basic quarantine probability of 40%.

**Scenario with Vaccination:**

30%, 50%, 90% of the total population.

**30% Population Vaccinated (Model 1)**

**50% Population Vaccinated (Model 2)**

**90% Population Vaccinated (Model 3)**

* All of the three graphs show similar pattern. Even though their patterns are similar, their actual values at the start of the simulation differs by a considerable amount.
* Number of uninfected Passengers in the 1st day: for 30% vaccinated is 180, for 50% vaccinated is 302 and for 90% vaccinated is 339.
* Days taken to completely wipe out the epidemic: for 30% vaccinated is 18, for 50% vaccinated is 20 and for 90% vaccinated is 27.

**Task 12.3**

Scenario with Mandatory Mask:

Everyone is required to wear a mask. Here we take quarantine probability of 40% and vaccination 0%.

We created two plots to understand the situation at a magnified level.

* The Annual plot shows a trend like trend of Basic Model with 50% quarantine.
* A curious fact about this model is, only 2 people remain uninfected for the entire simulation.
* The epidemic is wiped out on the 17th day.
* Due to mandatory mask requirements, the infection probability fall considerably. Because of this the number of initial infections rose slowly as compared to other base scenarios.

**Task 12.4**

Teleworking Scenario:

50% population are working from home and not commuting.

* These plots are done with half the population.
* The epidemic was wiped out within the 10th day. This thus comes after 100% quarantine in effectiveness (9 days).
* No passenger remained uninfected.