Mini-Project Draft Chapter 3 Report

**MA7080 Mathematical Modelling**

**Team: SRB60**

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# **Mini-Project Chapter 3 -Covid 19 Modelling**

Introduction:

To model the covid -19 pandemic, so far, we have used Exponential Model and Logistic Model for prediction in Chapter 1 and SIR model in Chapter 2. Now, for Chapter 3, we are extending the SIR model by introducing some psychological factors of human behaviour as per the classical theory of stress and general adaptation syndrome (GAS) by Hans Selye.

We are continuing our analysis using the below 3 countries:

1. The United Kingdom
2. United States of America
3. Italy

For analysis, we are considering the Cumulative Covid cases from the dataset : [WHO-COVID-19-global-data.csv](https://blackboard.le.ac.uk/bbcswebdav/pid-3142604-dt-content-rid-14290443_2/xid-14290443_2) .

Extended SIR Model

The SIR model has three states namely: Susceptible which is number of susceptible individuals, infected which is number of infected individuals and recovered is number of removed (recovered/dead) individuals.

According to the theory of GAS, there are three phases of Stress: Alarm, Resistance, and Exhaustion and therefore, we are introducing four types of human behaviour and four subpopulations in S:

* – “Ignorant people that do not know anything worrying about the epidemic.
* – people in “Alarm phase”.
* – people in “Resistance” state, with very rational and save behaviour.
* –people in “Exhaustion” state. They are tired of the epidemic, behave unsafe and do not

Therefore, we can write,

.

We can distribute the alarm phase partially in and and consider only 3 states as below.

and adding to SIR the transitions would be

By the law of conservation , .

# Task 1

For the Extended SIR model, we can write the stress reactions, their reaction rates, and Stoichiometric vectors as below where are the parameters reaction rate constants for each equation.

|  |  |  |
| --- | --- | --- |
| Reactions | Reaction rate | Stoichiometric vector |
|  |  | (-1, 0, 0, 1, 0)T |
|  |  | (-1, 1, 0, 0, 0)T |
|  |  | (0, -1, 1, 0, 0)T |
|  |  | (0, 0, -1, 1, 0)T |
|  |  | (0, 0, 0, -1, 1)T |
|  |  | (1, 0, -1, 0, 0)T |

We can write Kinetic equations as below:

We can consider the initial approximations as:

Reaction rate constant for 0.02

Reaction rate constant for 0.01

Reaction rate constant for , 1

# By taking the Normalized cumulative cases , we can plot the graph for Italy as shown below in Figure 1.

Chart, line chart

Description automatically generated

*Figure 1. Normalized Graph for Italy with covid start date as 24/02/2020*