"When can I use this in real life?"
Modelling Project Based Differential Equations

Meet Ashesi University

Mission

The mission of Ashesi University is to educate a new generation of ethical, entrepreneurial leaders in Africa; to cultivate within our students the critical thinking skills, the concern for others and the courage it will take to transform a continent.

Meet Ashesi University

https://www.ashesi.edu.gh/about/campus-tour.html

STUDENTS

1253 students
89% graduation rate in last 3 years.
47% of students are women
42% of students are on scholarships
52% of students on scholarships are women
17% are international students
1:21 student to faculty ratio
31 countries represented

FACULTY

36 full-time faculty
27 adjunct faculty
15 visiting faculty
10 academic support staff
42% women on university team
50% women on University Executive Team
55% women on the Board of Directors

CAMPUS

100 acres
13% solar-powered
Rain water storage
Wi-Fi in all academic buildings and residence halls
50% On campus housing
On campus Health Centre

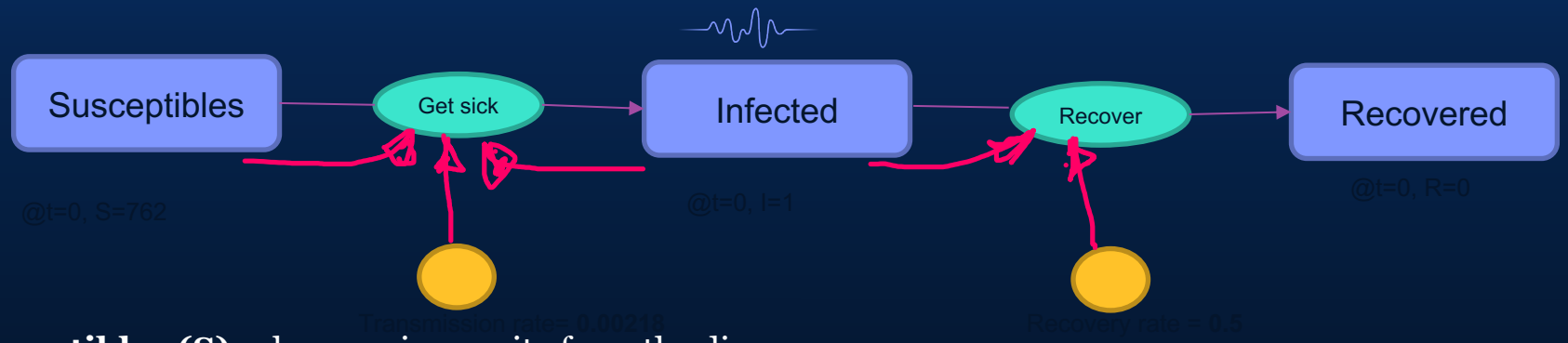
Mission

Train ethical entrepreneurial leaders in engineering
To train engineers who are **ethically grounded**, **technically strong and have the audacity** and empathy needed to solve the continent's most pressing challenges

Modelling with Differential Equations- as a model for “hands on”

- Interactive lessons with working out problems in groups and presenting
- Homework and some quizzes are completed in groups
- Identify current research articles that deal with a real-life application through modelling using ode(s)
- Understand the content of the paper, how the equations are derived and what they mean
- Understand the main points of the paper

Modeling practice

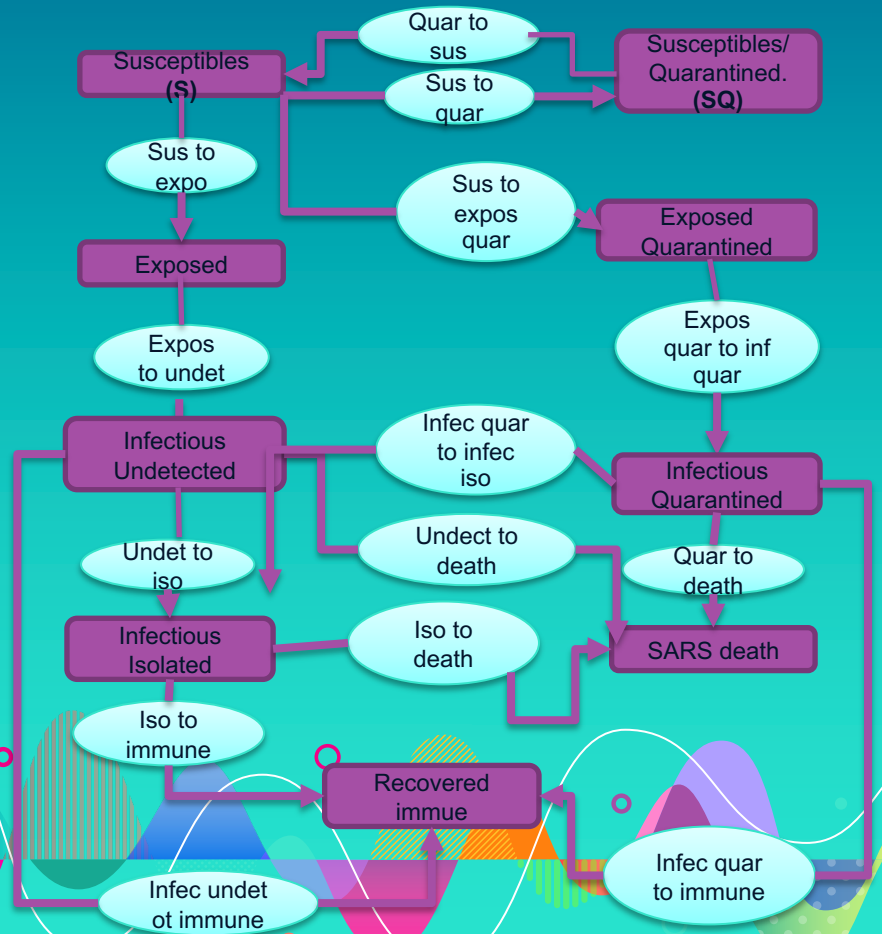


<u>Susceptibles (S)</u>. - have no immunity from the disease
<u>Infecteds (I)</u> - have the disease and can spread it to others
<u>Recovereds (R)</u> - have recovered from the disease and are immune to further infection

<u>Assumptions</u>

- Closed environment: **No births**
  No deaths
  No immigration
  No emigration
- Assume that after a certain amount of time, an individual with the disease recovers

Modelling practice



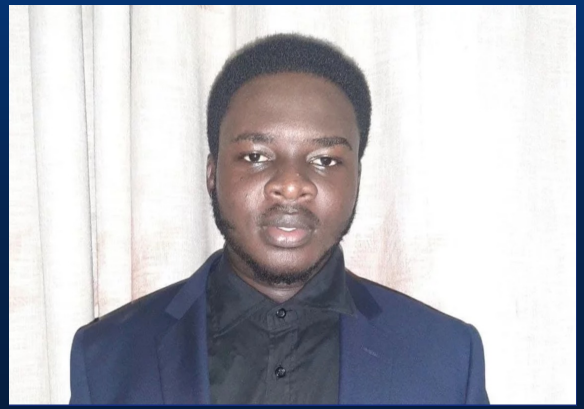
- Students take previous concepts to develop the equations
- Work with previous model to develop a Matlab script that they can use to investigate the behaviour of each group and discuss overall trends and behaviours

Project

- Identify current research articles that deal with a real-life application through modelling using ode(s)
- Understand the content of the paper, how the equations are derived and what they mean
- Understand the main points of the paper

Project Stages

1. Find a paper
2. Create one slide presentation with voice note introducing the paper and some brief notes to what you plan to do
3. Develop a creative representation of your project
4. Develop code and reproduce a figure
5. Introduce a modification or identify parameters for sensitivity analysis
6. Investigate the the effects of the new model changes or discuss the parameter sensitivity



Solvable delay model for epidemic spreading: the case of Covid-19 in Italy

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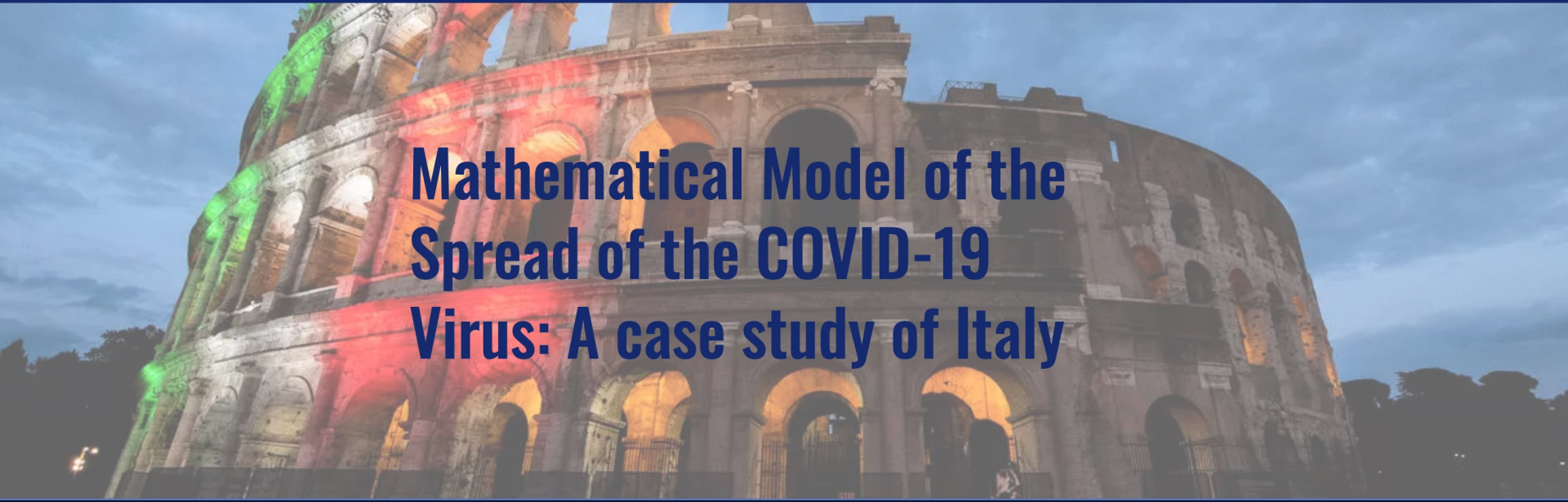
KWADWO ANSONG ANNOR-65072023

LINK: HTTPS://WWW.NATURE.COM/ARTICLES/S41598-020-72529-Y

ABSTRACT: WE STUDY A SIMPLE REALISTIC MODEL FOR DESCRIBING THE DIFFUSION OF AN INFECTIOUS DISEASE ON A POPULATION OF INDIVIDUALS. THE DYNAMICS IS GOVERNED BY A SINGLE FUNCTIONAL DELAY DIFFERENTIAL EQUATION, WHICH, IN THE CASE OF A LARGE POPULATION, CAN BE SOLVED EXACTLY, EVEN IN THE PRESENCE OF A TIME-DEPENDENT INFECTION RATE. THIS DELAY MODEL HAS A HIGHER DEGREE OF ACCURACY THAN THAT OF THE SO-CALLED SIR MODEL, COMMONLY USED IN EPIDEMIOLOGY, WHICH, INSTEAD, IS FORMULATED IN TERMS OF ORDINARY DIFFERENTIAL EQUATIONS. WE APPLY THIS MODEL TO DESCRIBE THE OUTBREAK OF THE NEW INFECTIOUS DISEASE, COVID-19, IN ITALY, TAKING INTO ACCOUNT THE CONTAINMENT MEASURES IMPLEMENTED BY THE GOVERNMENT IN ORDER TO MITIGATE THE SPREADING OF THE VIRUS AND THE SOCIAL COSTS FOR THE POPULATION.

Simulation and Analysis of COVID-19 Delay and SIR Model



Mathematical Model of the Spread of the COVID-19 Virus: A case study of Italy

Equations & Parameters used for SIR model

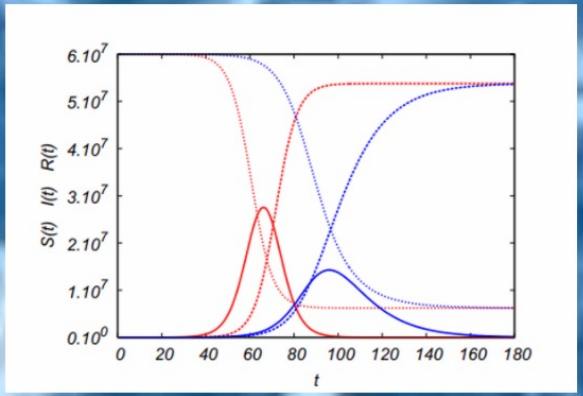
In defining, the model, some assumptions were made. For instance, it was assumed that the total population remains unchanged, uniform and homogeneously mixed.

The total population, N, was divided into three categories namely Susceptible(S), Infected(I) and Recovered(R). The population of these categories for any time(t), is given by *S(t), I(t) and R(t)*. It is also assumed the infected recover at a constant rate.

$$\frac{dS(t)}{dt} = -\frac{\alpha}{N} S(t) I(t)$$

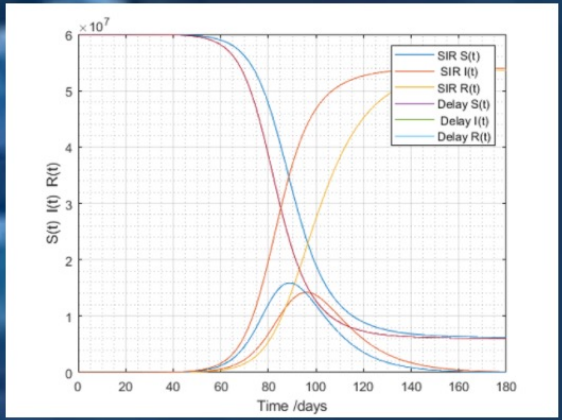
This equation describes the rate of change of the number of susceptible people with respect to time. **α** represents the infection rate and N is the total population. S(t) and I(t) represent the number of susceptible and number of infected at any given time respectively. The multiplication of S(t) & I(t) shows there is contact between the infected people and the number of susceptibles. The negative sign in front of the equation implies that the rate of susceptible people decreases with time as more people get infected by the virus.

Original Plots



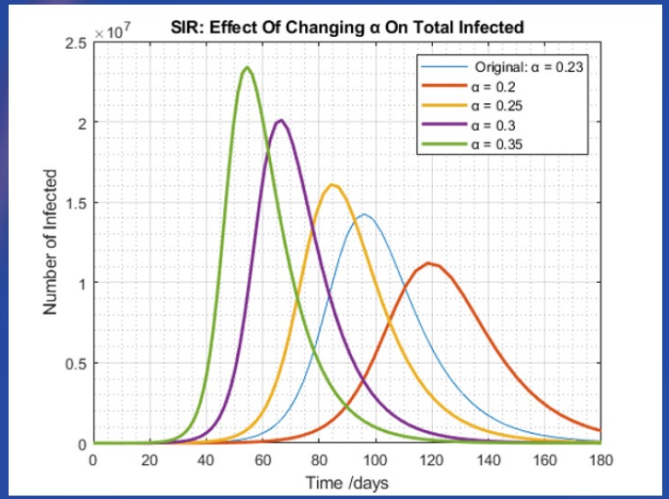
Plots of S(t), I(t), and R(t)

MATLAB Plots

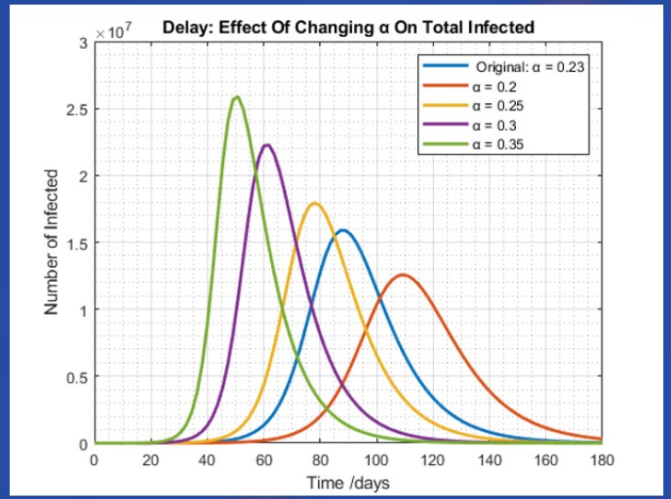


EFFECT OF PARAMETER ANALYSIS ON INFECTED

SIR Model

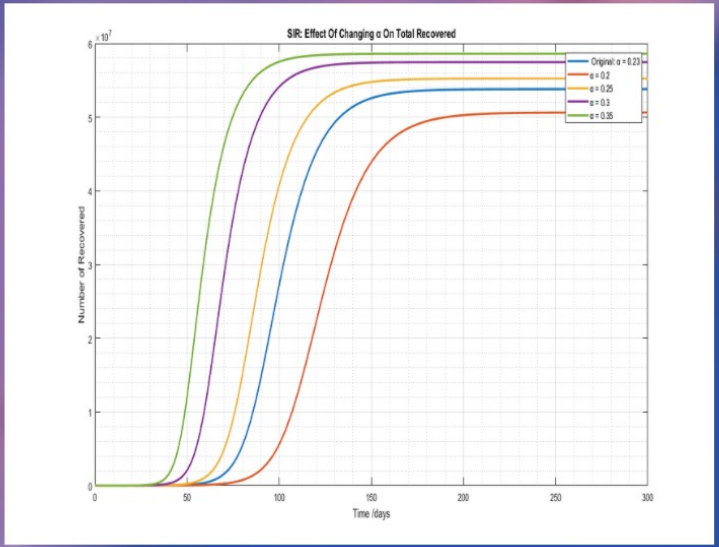


Delay Model

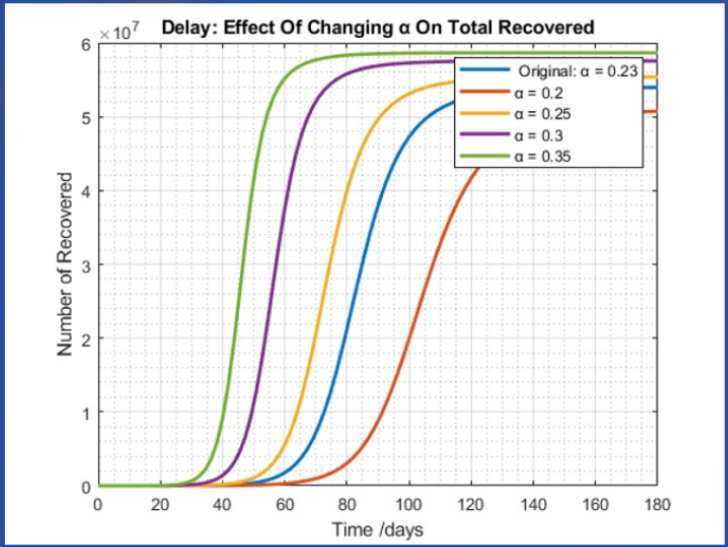


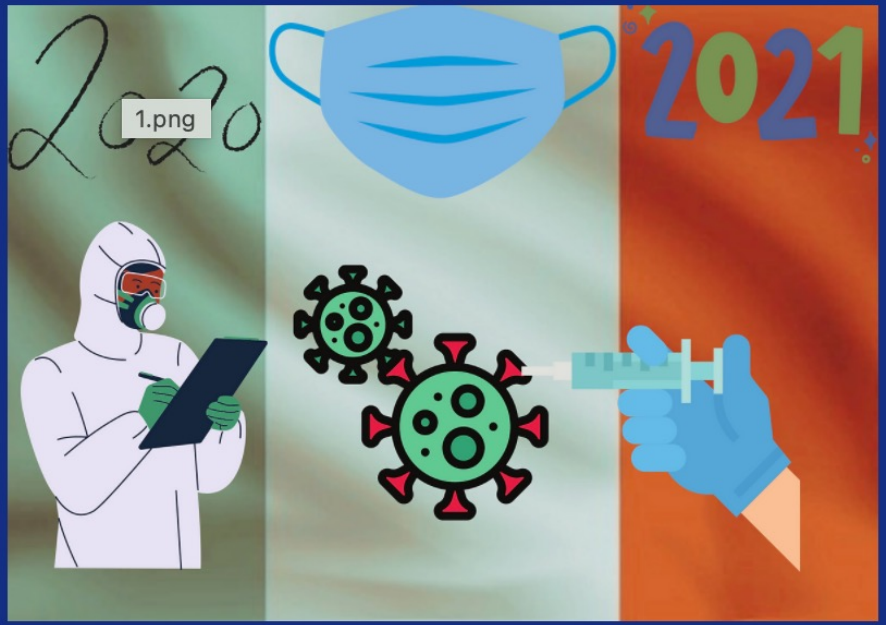
EFFECT OF PARAMETER ANALYSIS ON RECOVERED

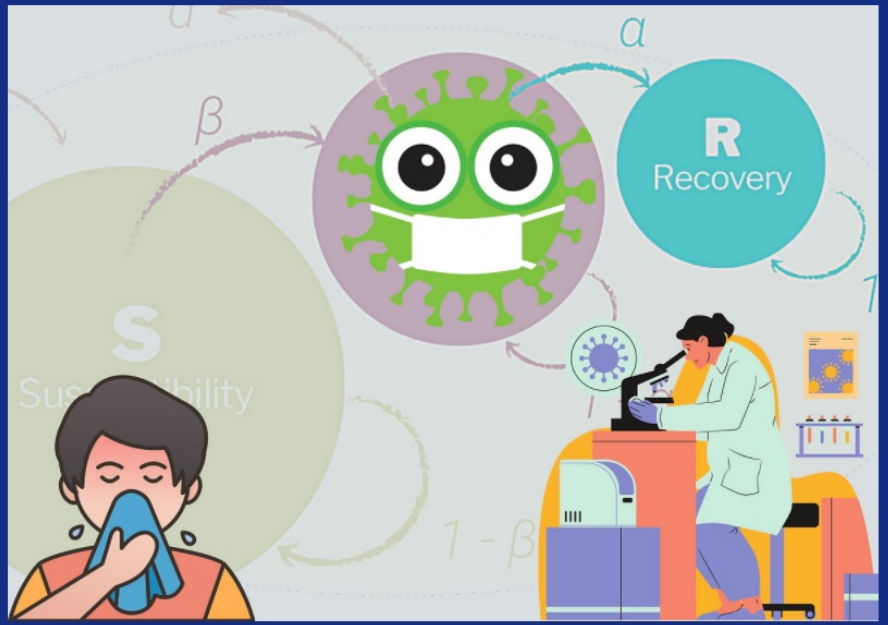
SIR Model



Delay Model




2020
1.png
2021


α
β
R
Recovery
S
1 - β

Parameter Analysis on a Model of the Viral Propagation of Memes Based on the SIR Model.

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Abstract – Internet memes, be it a joke or a piece of text, tend to go viral in a trend simila some infectious diseases. Using data from Google Trends as a check, Lin Wang and Brend a "viral memetic model" based on the SIR model to predict the trend in the viral spread o paper focuses on a parameter analysis of two memes modelled in Wang and Wood's pape meme joke and the term "blog." For the "O RLY" meme the transmission rate parameter observe its effects on the solution. It is observed that increasing the transmission rate by 0 higher peak value in the search volume index in a shorter number of days and vice versa f meme. For the term "blog," the proportionality constant of loss of interest is varied to obs solution of the viral memetic model. Here, increasing the value of the loss of interest prop resulted in a resulted in a decreased peak value which occurs at a higher number of days the opposite. This study reinforces the idea that the spread of ideas and concepts on the in be modelled in the form of infectious diseases.

Keywords – Memetic modelling, search volume index, meme, o rly, blog, interest, peak

I. INTRODUCTION

According to Merriam-Webster [1], a meme is an idea, behavior, style or usage that spreads between persons within a culture. This paper discusses the viral propagation of memes. More specifically, Davison [2], explains an internet meme as an element of culture which becomes popular through online interaction and circulation.

In the viral memetic model, the people who have not yet interacted *infectious* represent the people who a particular meme, have taken an ac are capable of sharing it to others. the people who have previously tak specific meme and have lost interes *recovered* do not necessarily spread

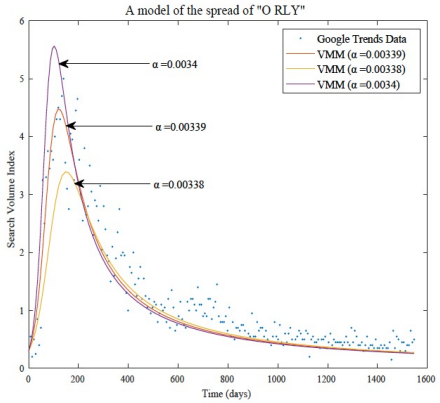


Fig 3. A spread of "O RLY" using varied α values from August 2005 to October 2009.

As seen in Fig3., using a smaller value of α (=0.00338), the peak of the graph drops by about 1, for the search volume index. This implies that the number of susceptible to get infected has reduced. The meme also gathers more interest than the original model, peaks for a longer period of 148 days, compared to 118 days. However, after it peaks there is still a gradual loss of interest in the "O RLY" meme over a period. Considering the inverse, for a greater value of α (=0.0034), the peak increases by 1. The susceptible to get infected increases but with this increase, the graph peaks for a shorter time, 102 days and then interest dies

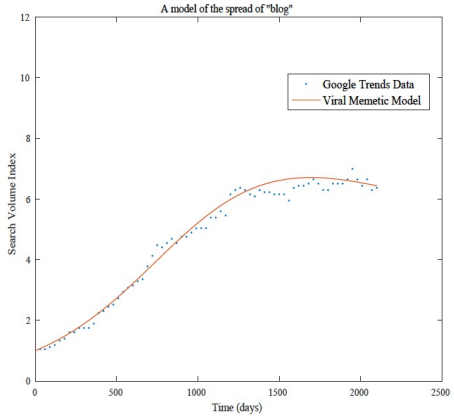
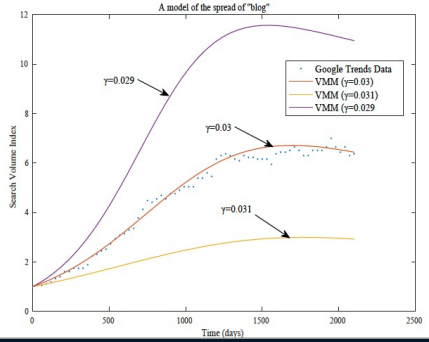


Fig. 4 Optimal parameters on "blog" from January 2004 to October 2009



Student’s comments

1. I noticed something similar to when we did Stats…my understanding of concepts became a lot better and more grounded with projects. So maybe a lot more of looking into research papers and trying to make meaning of concepts taught in class for the next Differential Equations and Numerical Methods class.
1. I enjoyed this class so much especially the part where we worked on the project of analyzing the scientific papers which were about ODEs. The more we applied the concepts through this project, the more I understood them. It was a such a great experience to learn how these concepts in class are being used out there. I hope to see such situations in my future career.
1. I like how although classes are virtual you made the concepts as practical as possible
1. Dr Rosca is one of the few lecturers who make me feel I can apply the things taught in class to real life applications. This course, I'm not just studying to get good grades but I am given insight on how the topics taught are applicable to real life scenario and my career path. Right from statistics and engineering to differential equations, she teaches in a way to ensure we understand and she ensures to chip in the applications. I really like the way she teaches and the way the course is designed. Thank you Dr Rosca!

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Modelling Malaria Propagation: A Factor Significance Analysis