SOME FUCKING TITLE

SDIV, FPA, DGS, GASV

Abstract.

1. Introduction

2. Model Formulation

Hypothesis. We consider that susceptible individuals become infected when they are in contact with asymptomatic individuals and individuals with symptoms, we will propose that a proportion of asymptomatic individuals have a way to get relief and not die. A proportion of individuals infected with symptoms may die from the disease or may be relieved. We will introduce two types of control, vaccination of asymptomatic infected and susceptible individuals and treatment of individuals infected with symptoms.

$$\begin{aligned}
\dot{S} &= -\beta\frac{S}{N}(I_s+\alpha I_a) - uS \\
\dot{I}_a &= p\beta\frac{S}{N}(I_s+\alpha I_a) - (\rho+u)I_a \\
\dot{I}_s &= (1-p)\beta\frac{S}{N}(I_s+\alpha I_a) - (\gamma+\delta+v)I_s \\
\dot{R}_a &= \rho I_a \\
\dot{R}_s &= \gamma I_s \\
\dot{D} &= \delta I_s \\
\dot{V} &= u(S+I_a) \\
\dot{T} &= vI_s \\
& S(0)=S_0, I_a(0)=I_{a_0}, I_s(0)=I_{s_0}, \\
& R_a(0)=R_{a_0}, R_s(0)=R_{s_0}, \\
& D(0)=D_0, T(0)=T_0, \\
N(t) &= (S+I_a+I_s+R_a+R_s+D+V+T)(t)=cte. \\
& 0\le u(t)\le u_0, 0\le v(t)\le v_0,
\end{aligned} \tag{1}$$

$$J(\vec{x},\vec{u}) = \int_0^T (I_a(t)+I_s(t)+D(t)+d_1u(t)+d_2v(t))dt \tag{2}$$

where

$$\vec{x}=(S,I_a,I_s,R_a,R_s,D,V,T), \vec{u}=(u,v)$$

3. Adimensional Model

$$
\begin{aligned}
\dot{\tilde{S}} &= -\beta\tilde{S}(\tilde{I}_s+\alpha\tilde{I}_a)-u\tilde{S}\\
\dot{E} &= \beta\tilde{S}(\tilde{I}_s+\alpha\tilde{I}_a)-\kappa E\\
\dot{\tilde{I}}_a &= p\kappa\ E-(\rho+u)\tilde{I}_a\\
\dot{\tilde{I}}_s &= (1-p)\kappa\ E-(\gamma+\delta+v)\tilde{I}_s\\
\dot{\tilde{R}}_a &= \rho\tilde{I}_a\\
\dot{\tilde{R}}_s &= \gamma\tilde{I}_s\\
\dot{\tilde{D}} &= \delta\tilde{I}_s\\
\dot{\tilde{V}} &= u(\tilde{S}+\tilde{I}_a)\\
\dot{\tilde{T}} &= v\tilde{I}_s\\
&\tilde{S}(0)=\tilde{S}_0, \tilde{I}_a(0)=\tilde{I}_{a_0}, \tilde{I}_s(0)=\tilde{I}_{s_0},\\
&\tilde{R}_a(0)=\tilde{R}_{a_0}, \tilde{R}_s(0)=\tilde{R}_{s_0},\\
&\tilde{D}(0)=\tilde{D}_0, \tilde{T}(0)=\tilde{T}_0,\\
N(t) &= (\tilde{S}+\tilde{I}_a+\tilde{I}_s+\tilde{R}_a+\tilde{R}_s+\tilde{D}+\tilde{V}+\tilde{T})(t)=1.\\
&0\le \tilde{S},\tilde{I}_a,\tilde{I}_s,\tilde{R}_a,\tilde{R}_s,\tilde{D},\tilde{V},\tilde{T}\le 1\\
&0\le u(t)\le 1, \qquad 0\le v(t)\le 1,
\end{aligned} \tag{3}
$$

$$
J(\vec{\tilde{x}},\vec{\tilde{u}}) = \int_0^T \tilde{I}_a(t)+\tilde{I}_s(t)+\tilde{D}(t)+d_1u(t)+d_2v(t)dt \tag{4}
$$

4. SEIR version

Here we propose a SEIR struture which considers hospitlized compartiment H. To overcome stability issues we also consider vital dynamics.

$$
\begin{aligned}
&\min_{u\in\mathcal{U}} = \int_0^T \left(a_{I_S} I_S + a_H H + a_D D + \frac{a_L}{2}u_L^2 + \frac{a_V}{2}u_V^2 + \frac{a_H}{2}u_H^2 + \frac{a_M}{2}u_M^2\right) dt \\
&\text{s. t.} \\
&\begin{aligned}
L' &= -\epsilon\lambda L - u_L(t)L - \mu L \\
S' &= \mu N^\star + u_L(t)L + (1-\widehat{q})\gamma_V V - \lambda S - u_V(t)S - \mu S \\
E' &= \lambda(\epsilon L + S) - \kappa E - \mu E \\
I_S' &= p\kappa E - (\gamma_S + \mu_{I_S} + \delta_H) I_S - u_M(t) I_S + (1-q)\gamma_M M(t) - \mu I_S \\
I_A' &= (1-p)\kappa E - \gamma_A I_A - \mu I_A \\
M' &= u_M(t) I_S - \gamma_M M - \mu M \\
H' &= \delta_H I_S - (\gamma_H + \mu_H) H - u_H(t) H - \mu H \\
R' &= \gamma_S I_S + \gamma_A I_A + \gamma_H H + q\gamma_M M + u_H(t) H + \widehat{q}\gamma_V V - \mu R \\
D' &= \mu_{I_S} I_S + \mu_H H \\
V' &= u_V(t) S - \gamma_V V - \mu V \\
\lambda &:= \frac{\beta_A I_A + \beta_S I_S}{N^\star} \\
N^\star(t) &= L + S + E + I_S + I_A + M + H + R + V
\end{aligned}
\end{aligned} \tag{5}
$$

Minima Squares.
Likelihood.
Bayesian.

5. Optimal control problem

6. Numerical Results