Math 42 Assignment 1

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Instructions:

- The paper "The Mathematics of Gossip" by Jessica Deters and Izabal Aguiar, and Jacquie Feuerborn presents an epidemiologic model for the spread of gossip in a community. The objective of this assignment is to study different steps in the design of a mathematical model and propose a strategy to control the spread of the gossip.

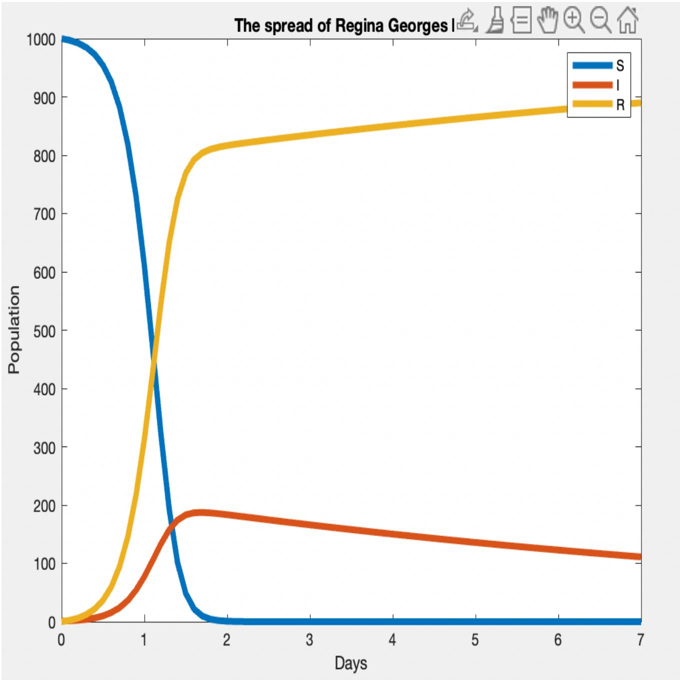
Problems

1. Using the paper, identify the assumptions of the model, the relevant variables, and the relationship between the relevant variables.

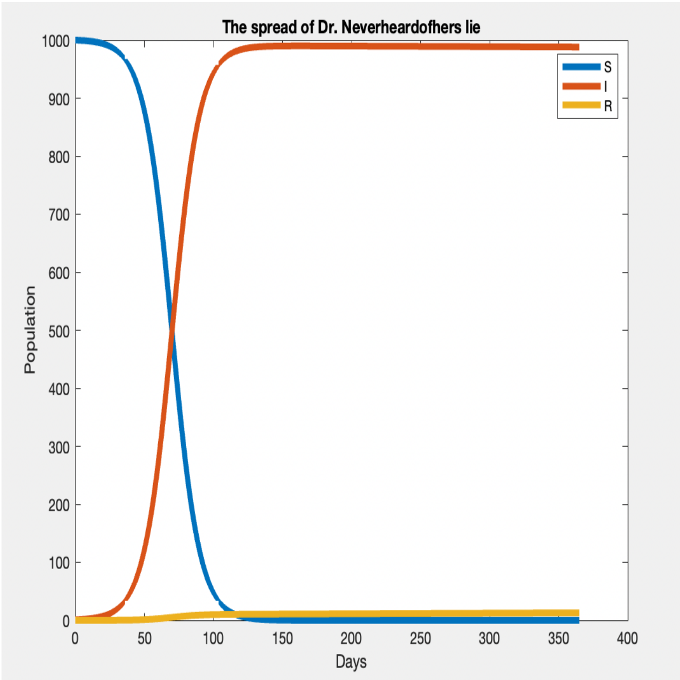
   The author of the paper used ISR mathematics modeling for the assumption. In detail, they set up their assumption: the spreading of gossip is false. There were three possible ways to demonstrate the population: those susceptible to the gossip(S), infected with the gossip(I), and recovered from the gossip(R). Based on this definition, there was a fixed equation of the population in the system which is N = S + I + R. There are four lie-dependent parameters, β, γ, ρ, and α. They assume that upon hearing the gossip for the first time, (1-p) proportion of the population will immediately know. The four parameters are: Parameters β and γ describe the rates at which the lie is believed and rejected as false, ρ describes the percentage of the population immune to the lie, and α describes the rate at which the recovered population becomes re-infected with the lie. Based on these different parameters, they made the three equations for the modeling:
   $\frac{dS}{dt} = -\beta \cdot S \cdot I$
   $\frac{dI}{dt} = \rho \cdot \beta \cdot S \cdot I - \gamma \cdot I + \alpha \cdot R$
   $\frac{dR}{dt} = \gamma \cdot I - \alpha \cdot R + (1 - \rho) \cdot \beta \cdot S \cdot I$

2. Write a computer code (MATLAB, MATHEMATICA, C++, or any other code) to reproduce the graphs in the paper.

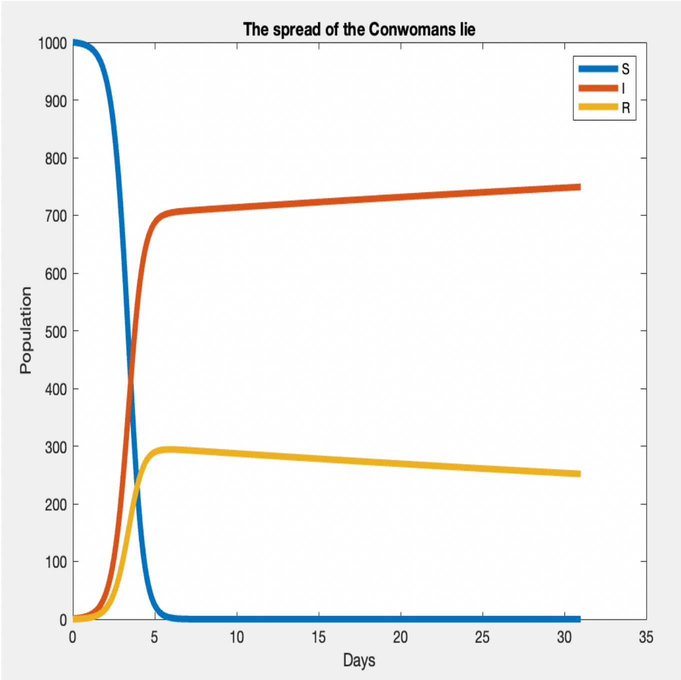
```matlab
% Regina George's lie case
% given parameters
beta = 0.03;
gamma = 0.1;
p = 0.2;
alpha = 0;

dt = 0.1;
D = 7.; % Days
N_t = floor(D/dt);

t = linspace(0, N_t*dt, N_t+1);
S = zeros(N_t+1, 1);
I = zeros(N_t+1, 1);
R = zeros(N_t+1, 1);

% Initial condition
S(1) = 1000;
I(1) = 1;
R(1) = 0;

% Step equations forward in time
for n = 1:N_t
   S(n+1) = S(n) - dt*beta*S(n)*I(n);
   I(n+1) = I(n) + dt*p*beta*S(n)*I(n) - dt*gamma*I(n) + dt*alpha*R(n);
   R(n+1) = R(n) + dt*gamma*I(n) - dt*alpha*R(n) + dt*(1-p)*beta*S(n)*I(n);
end

plot(t, S, t, I, t, R, 'LineWidth',4);
title('The spread of Regina Georges lie');
legend('S', 'I', 'R');
xlabel('Days');
ylabel('Population');
print('tmp', '-dpdf');  print('tmp', '-dpng');
```



```matlab
% Dr. Neverheardofher's case
% given parameters
beta = 0.0001;
gamma = 0.00001;
p = 0.99;
alpha = 0.;

dt = 0.1;
D = 365.; % Days
N_t = floor(D/dt);

t = linspace(0, N_t*dt, N_t+1);
S = zeros(N_t+1, 1);
I = zeros(N_t+1, 1);
R = zeros(N_t+1, 1);

% Initial condition
S(1) = 1000;
I(1) = 1;
R(1) = 0;

% Step equations forward in time
for n = 1:N_t
   S(n+1) = S(n) - dt*beta*S(n)*I(n);
   I(n+1) = I(n) + dt*p*beta*S(n)*I(n) - dt*gamma*I(n) + dt*alpha*R(n);
   R(n+1) = R(n) + dt*gamma*I(n) - dt*alpha*R(n) + dt*(1-p)*beta*S(n)*I(n);
end

plot(t, S, t, I, t, R, 'LineWidth',4);
title('The spread of Dr. Neverheardofhers lie');
legend('S', 'I', 'R');
xlabel('Days');
ylabel('Population');
print('tmp', '-dpdf');  print('tmp', '-dpng');
```



```
% The Conwoman's lie case
% given parameters
beta = 0.003;
gamma = 0.001;
p = 0.7;
alpha = 0.009;

dt = 0.1;
D = 31.; % Days
N_t = floor(D/dt);

t = linspace(0, N_t*dt, N_t+1);
S = zeros(N_t+1, 1);
I = zeros(N_t+1, 1);
R = zeros(N_t+1, 1);

% Initial condition
S(1) = 1000;
I(1) = 1;
R(1) = 0;

% Step equations forward in time
for n = 1:N_t
   S(n+1) = S(n) - dt*beta*S(n)*I(n);
   I(n+1) = I(n) + dt*p*beta*S(n)*I(n) - dt*gamma*I(n) + dt*alpha*R(n);
   R(n+1) = R(n) + dt*gamma*I(n) - dt*alpha*R(n) + dt*(1-p)*beta*S(n)*I(n);
end

plot(t, S, t, I, t, R, 'LineWidth',4);
title('The spread of the Conwomans lie');
legend('S', 'I', 'R');
xlabel('Days');
ylabel('Population');
print('tmp', '-dpdf');  print('tmp', '-dpng');
```



I attached the 'github' link for the code:
https://github.com/lunamk24/math42/blob/main/assignment1.m

3. Propose a mathematical modeling strategy to control the spread of the gossip

   At the end of the paper, the author pointed out that the model developed in this paper has the potential to be altered to include more complicated scenarios. It is clear that there will be a lot of different factors that could impact controlling the spread of gossip by showing three different of modeling in the paper. It will have better mathematical modeling output if they have the other variable like parameter: the probability rate based on their job and central reputation in the world. Depending initial gossip spreader's job, the rate of belief in the failure of gossip shows differently. Additionally, To control the spread of gossip, it is important that a socially influential person with a stable reputation delivers the correct information quickly.

   There is another strategy I could suggest to control the spread of gossip: the quantity and credibility of the evidence. It means that It might be stronger mathematical modeling if they add the parameter about the evidence of gossip. There will be totally different results between gossip itself and gossip with detailed evidence when starters spread rumors. Following this, people will believe and trust gossip with a high probability that it has a lot of proof to prove. By using those two factors, they would build more strategic mathematical modeling to control the spread of gossip.