Introduction: What is a mask?

A mask in health is a protective covering worn over the nose and mouth to help prevent the spread of respiratory infections, such as COVID-19. Masks can filter out harmful particles and reduce the transmission of germs between individuals. However, the question to ask is “how effective does a mask have to be to substantially impact the spread of a disease?”

Baseline Dataset (no masks):

First we define our parameters for the baseline data set:

```
S_1 = 99;% Susceptible people
I_1 = 1; % Infected people
R_1 = 0; % Recovered people

i = 0.9; % Infectivity rate is 90% according to the CDC
r = 0.0714; % The average person takes two weeks to recover

m = 1; % Mask effectiveness (1 is worst, 0 is best)

t_end = 40; % Time simulation end, in weeks
```

These parameters define the infectivity rate, the recovery rate, and the initial starting infected and healthy population. The initial recovered rate is always 0.

Next we run it through our equations:

```
% Normal Model
% S(t+1) = S(t) - (I(t) * S(t) * i)
% I(t+1) = I(t) + (I(t) * S(t) * i) - (I(t) * r)
% R(t+1) = R(t) + (I(t) * r)

% Mask Model
% S(t+1) = S(t) - (I(t) * S(t) * i * m)
% I(t+1) = I(t) + (I(t) * S(t) * i * m) - (I(t) * r)
% R(t+1) = R(t) + (I(t) * r)
```

These equations allow us to model the spread of the disease and how masks will impact it, allowing us to do a comparison on how masks affect the spread of disease.

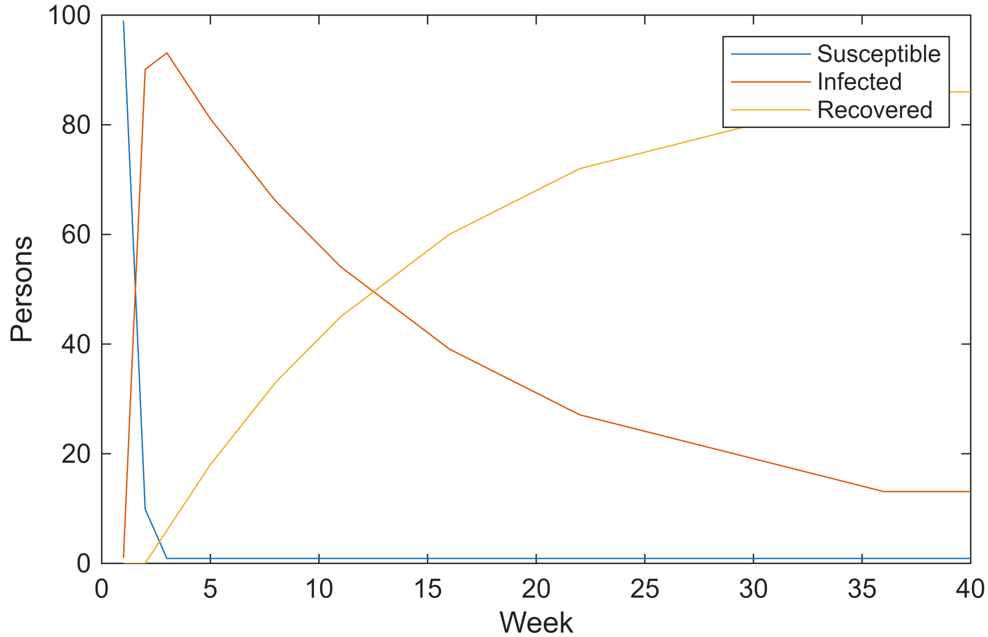
Now we get our baseline data plot:

```
[S, I, R, W] = simulate_sir(S_1, I_1, R_1, m, i, r, t_end);

% Plot - baseline
figure()
plot(W, S, 'DisplayName', 'Susceptible'); hold on
plot(W, I, 'DisplayName', 'Infected')
```

```
plot(W, R, 'DisplayName', 'Recovered')

xlabel("Week")
ylabel("Persons")
legend()
```



This data plot shows a large spike in infectivity right at the start, which aligns with the statement from the CDC about measles being one of the most infective diseases known to man, with a roughly 90% infectivity rate. The recovered population curves, as to be expected with it taking on average 14 days for an individual to fully recover, as stated by the CDC.

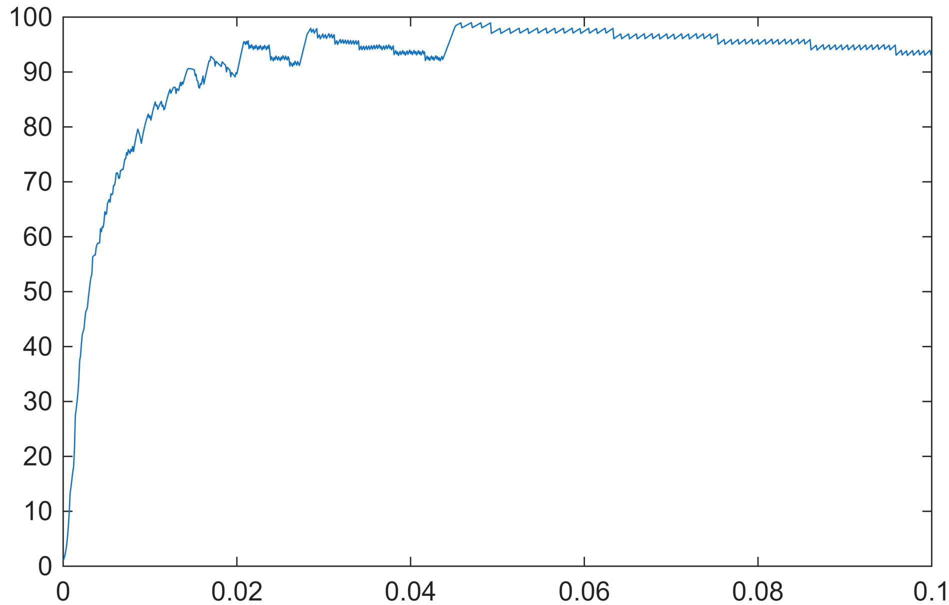
Finding the mask effectiveness that cuts the peak infected number to 50% of the original value:

To find the mask effectiveness value that would cut the peak infected number by 50%, we will be performing a parameter sweep. To do this, we will graph a set of mask effectiveness values against their respective peak infected population until we find one that is 50% of the peak infected population when mask effectiveness is 1 (no masks being worn).

```
maxI = max(I);
idealI = maxI/2;
IxMax = zeros(1, 1000);
MiList = .1:-0.0001:0;
answer = 0;
count = 1;

for mi = MiList
    [Sx, Ix, Rx, Wx] = simulate_sir(S_1, I_1, R_1, mi, i, r, t_end);
    IxMax(count) = max(Ix);
    count = count + 1;
```

```
end
figure()
plot(MiList, IxMax, 'DisplayName', 'wahhhhh')
```




```
for mi = MiList
    [Sx, Ix, Rx, Wx] = simulate_sir(S_1, I_1, R_1, mi, i, r, t_end);
    if idealI > max(Ix)
        answer = mi;
        break
    end
end
answer
```

```
answer =
0.0026
```

Based on this data, a mask effectiveness of 99.74%, will reduce the peak infected population by 50%. This means that a mask like a Elastomeric respirators (with P100 filters) or more effective, would be an ideal mask for everyone to wear during a measles outbreak. Although this does not account for recovered people being reinfected (yet) or them dying of the measles (yet), this model can help us recommend a mask for the population to wear during a measles outbreak to help contain the spread of the virus.