Project Team 3

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This .mlx file aims to generate replicated results for the SEIR model in Hou et al. as well as to create a randomized contact network matrix, both in the attempt to simulate the transmission of COVID-19 within communities and affected groups.

COVID SEIR Model

Using the SEIR Hou et al. Model:

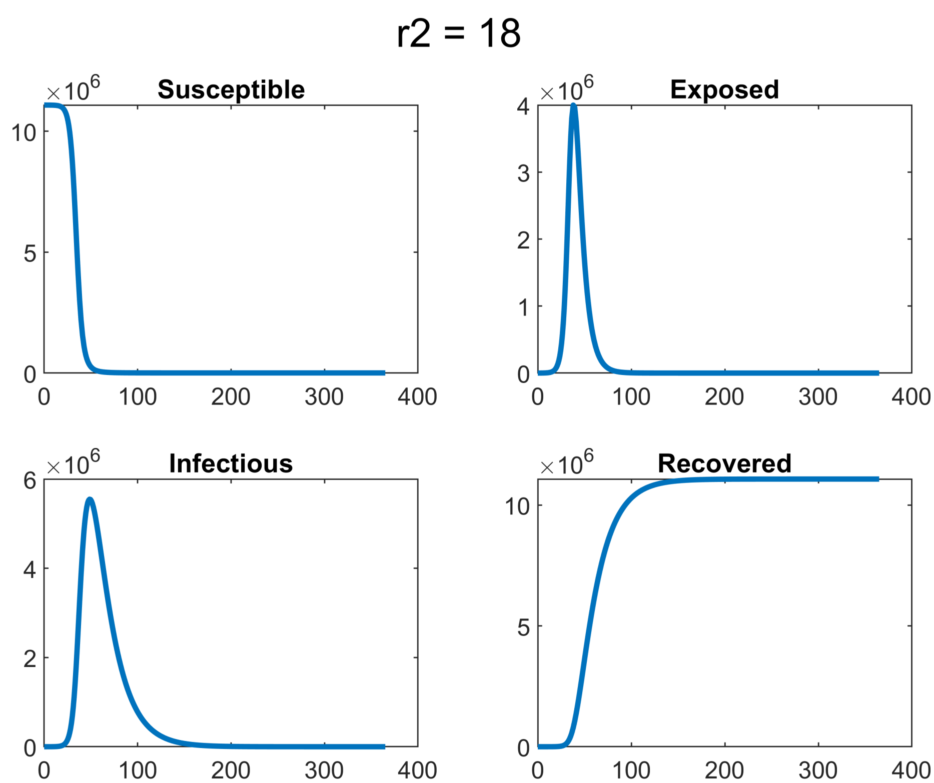
Generate Approximated Time Course of COVID Transmission

```
% Input for ode45 function
input_vector = [11080778 193 27 2]; % [Susceptible, Exposed, Infectious, Recovered]
time = [0 365]; % time in days

% Ode45 function
[T,Y] = ode45(@basic_model, time, input_vector);
```

Plot SEIR Model Results Over Time Course for Individuals

```
% Plot changes in groups for SEIR covid model for r = 18

% Create figure
figure

% Hold onto the same figure
hold on

% Provide figure title
sgtitle('r2 = 18')

% Create 4 subplots, and target the first subspace
subplot(2,2,1)

% Plot susceptible
plot(T,Y(:,1), 'LineWidth', 2)

% Add title
title('Susceptible')

% Target second subspace
subplot(2,2,2)

% Plot exposed
plot(T,Y(:,2), 'LineWidth', 2)

% Add title
title('Exposed')
```

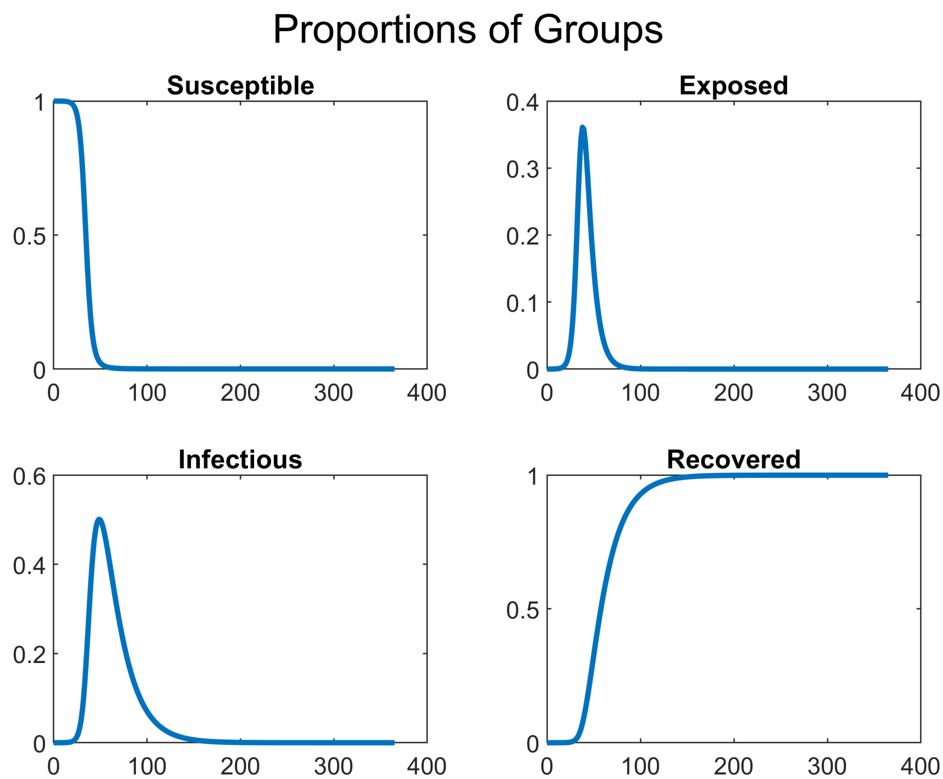
```
% Target third subspace
subplot(2,2,3)

% Plot infected
plot(T,Y(:,3), 'LineWidth', 2)

% Add title
title('Infectious')

% Target fourth subspace
subplot(2,2,4)

% Plot recovered
plot(T,Y(:,4), 'LineWidth', 2)

% Add title
title('Recovered')

% Let go of figure
hold off
```



Plot SEIR Model Results Over Time Course for Proportions

```
% Plot changes in groups for covid model for r = 18

% Create new figure
```

```
figure

% Hold onto figure
hold on

% Create figure title
sgtitle('Proportions of Groups')

% Target first subspace of new figure
subplot(2,2,1)

% Plot proportion of susceptible
plot(T,Y(:,1)./11081000, 'LineWidth', 2)
title('Susceptible')

% Target second subspace of new figure
subplot(2,2,2)

% Plot proportion of exposed
plot(T,Y(:,2)./11081000, 'LineWidth', 2)
title('Exposed')

% Target third subspace of new figure
subplot(2,2,3)

% Plot proportion of infected
plot(T,Y(:,3)./11081000, 'LineWidth', 2)
title('Infectious')

% Target fourth subspace of new figure
subplot(2,2,4)

% Plot proportion of recovered
plot(T,Y(:,4)./11081000, 'LineWidth', 2)
title('Recovered')

% Hold off of figure
hold off
```

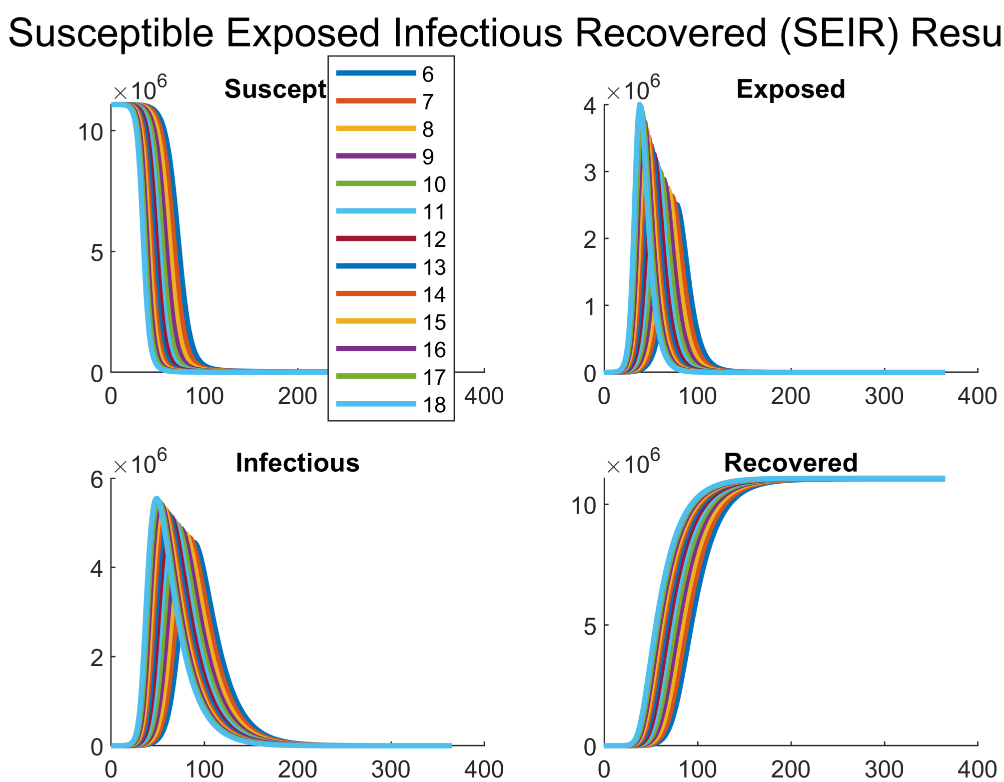


Generate Approximated Time Course of COVID Transmission Across Different Contact Rates (r2)

```
% Create a new figure
figure

% Hold onto figure
hold on

% Vary r2 from 6 to 18
rate_varying = 6:18;

% Iterate through the covid model with different r2 values and plot the
% results
for l = rate_varying

    % Simulate time course of transmission with input of r2 as the
    % iterative l
    [T,Y] = ode45(@(t,y) basic_model(t,y,l), time, input_vector);

    % Target first subplot
    subplot(2,2,1)

    % Hold onto subplot
    hold on

    % Plot susceptible individuals
```

```
    plot(T,Y(:,1), 'LineWidth', 2)

    % Add title
    title('Susceptible')

    % Target second subplot
    subplot(2,2,2)

    % Hold onto subplot
    hold on

    % Plot exposed individuals
    plot(T,Y(:,2), 'LineWidth', 2)

    % Add title
    title('Exposed')

    % Target third subplot
    subplot(2,2,3)

    % Hold onto subplot
    hold on

    % Plot infected individuals
    plot(T,Y(:,3), 'LineWidth', 2)

    % Add title
    title('Infectious')

    % Target fourth subplot
    subplot(2,2,4)

    % Hold onto subplot
    hold on

    % Plot recovered individuals
    plot(T,Y(:,4), 'LineWidth', 2)

    % Add title
    title('Recovered')

    % Find the peak individuals per category and at what times they
    % occurred for each r2 value
    maxima(:,l-5) = [max(Y(:,1)); max(Y(:,2)); max(Y(:,3)); max(Y(:,4))];
    times(:,l-5) = [T(find(Y(:,1) == max(Y(:,1)))), T(find(Y(:,2) == max(Y(:,2)))), T(find(Y(:,
end

% Return to the first subplot
subplot(2,2,1)
```

```
% Hold onto the first subplot
hold on

% Add an overall title
sgtitle('Susceptible Exposed Infectious Recovered (SEIR) Results')

% Add a legend
legend({'6', '7', '8', '9', '10', '11', '12', '13', '14', '15', '16', '17', '18'}, 'Location',

% Hold off
hold off
```

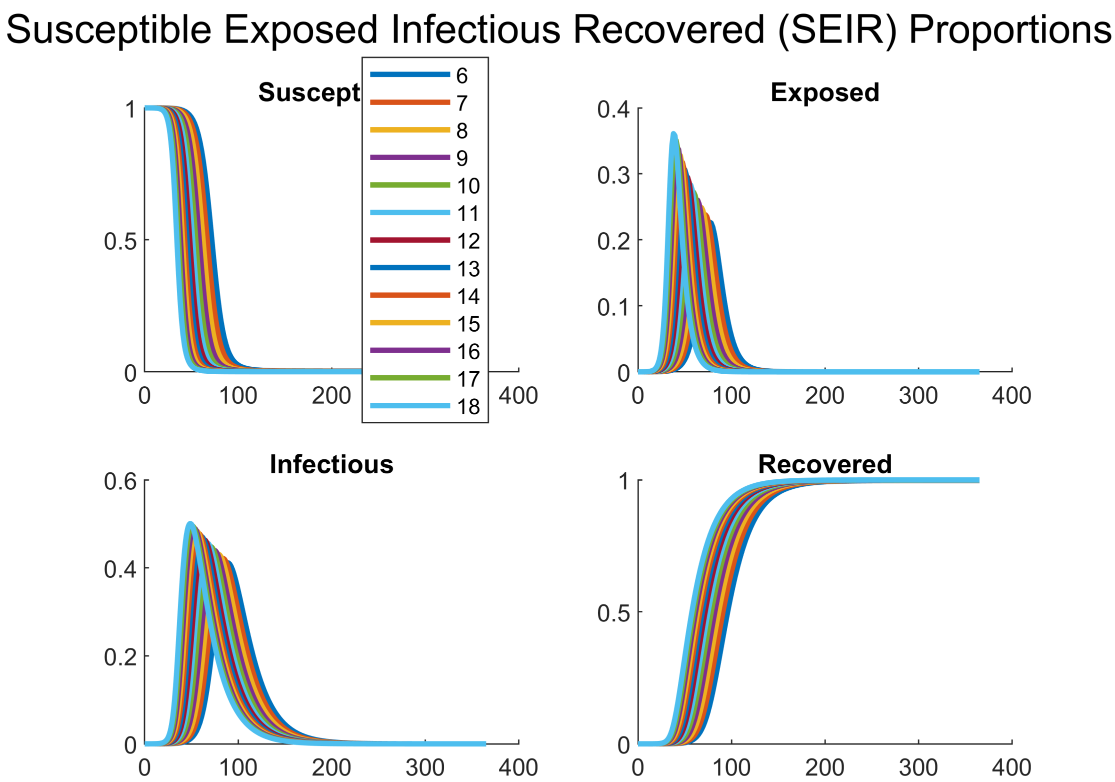



```

```

Generate Approximated Time Course of COVID Transmission Across Different Contact Rates (r2) and Use Proportions Instead

```
% Create a new figure
figure

% Hold onto figure
hold on

% Vary r2 from 6 to 18
rate_varying = 6:18;

% Iterate through the covid model with different r2 values and plot the
```

```
% results

% comments are similar to the previous code, but using division with the
% total number of individuals
for l = rate_varying
    [T,Y] = ode45(@(t,y) basic_model(t,y,l), time, input_vector);
    subplot(2,2,1)
    hold on
    plot(T,Y(:,1)./11081000, 'LineWidth', 2)
    title('Susceptible')
    subplot(2,2,2)
    hold on
    plot(T,Y(:,2)./11081000, 'LineWidth', 2)
    title('Exposed')
    subplot(2,2,3)
    hold on
    plot(T,Y(:,3)./11081000, 'LineWidth', 2)
    title('Infectious')
    subplot(2,2,4)
    hold on
    plot(T,Y(:,4)./11081000, 'LineWidth', 2)
    title('Recovered')

    % Find the peak individuals per category and at what times they
    % occurred for each r2 value
    maxima(:,l-5) = [max(Y(:,1)); max(Y(:,2)); max(Y(:,3)); max(Y(:,4))];
    times(:,l-5) = [T(find(Y(:,1) == max(Y(:,1)))), T(find(Y(:,2) == max(Y(:,2)))), T(find(Y(:,
end
subplot(2,2,1)
hold on
sgtitle('Susceptible Exposed Infectious Recovered (SEIR) Proportions')
legend({'6', '7', '8', '9', '10', '11', '12', '13', '14', '15', '16', '17', '18'}, 'Location',
hold off
```



Results

Table Creation of Comparison of Time and Individuals over Different r2 Rates

```
% Create a table of the r2 values with their respective peak time for both
% exposed and infectious individuals
Table2 = table(rate_varying', times(2,:)', maxima(2,:)', times(3,:)', maxima(3,:)', 'VariableNa
```

```
Table2 = 13×5 table
```

...

	r2	Peak Time (Days) for Exposed Individuals	Peak Exposed Individuals
1	6	76.4320	2.5120e+06
2	7	72.0765	2.6374e+06
3	8	67.9799	2.7563e+06
4	9	63.7391	2.8826e+06
5	10	59.4497	3.0149e+06
6	11	56.3213	3.1374e+06
7	12	53.0115	3.2659e+06
8	13	50.0505	3.3929e+06
9	14	47.4949	3.5159e+06
10	15	45.2694	3.6325e+06

	r2	Peak Time (Days) for Exposed Individuals	Peak Exposed Individuals
11	16	41.6390	3.7488e+06
12	17	40.7125	3.8860e+06
13	18	37.8889	3.9995e+06

Comparison of Exposure vs. Infectious Individuals for Basic Model

```
% Creat new figure
figure

% Hold onto the figure
hold on

% On the left y-axis
yyaxis left

% Plot the times at which peak occur
plot(rate_varying', times(2,:)', '-b*', rate_varying', times(3,:)', '-bo')

% Provide x and y labels
xlabel('Rate Varying by r2')
ylabel('Peak Time (Days)', 'Color', 'b')

% Provide a title
title('Comparison of Exposure vs. Infectious Individuals')

% On the right y-axis
yyaxis right

% Plot the max individuals
plot(rate_varying', maxima(2,:)', '-r*', rate_varying', maxima(3,:)', '-ro')

% Provide a label on the y-axis
ylabel('Peak Individuals (Persons)', 'Color', 'r')

% Provide a legend
legend('Exposed Time', 'Infectious Time', 'Exposed Individuals', 'Infectious Individuals')
```

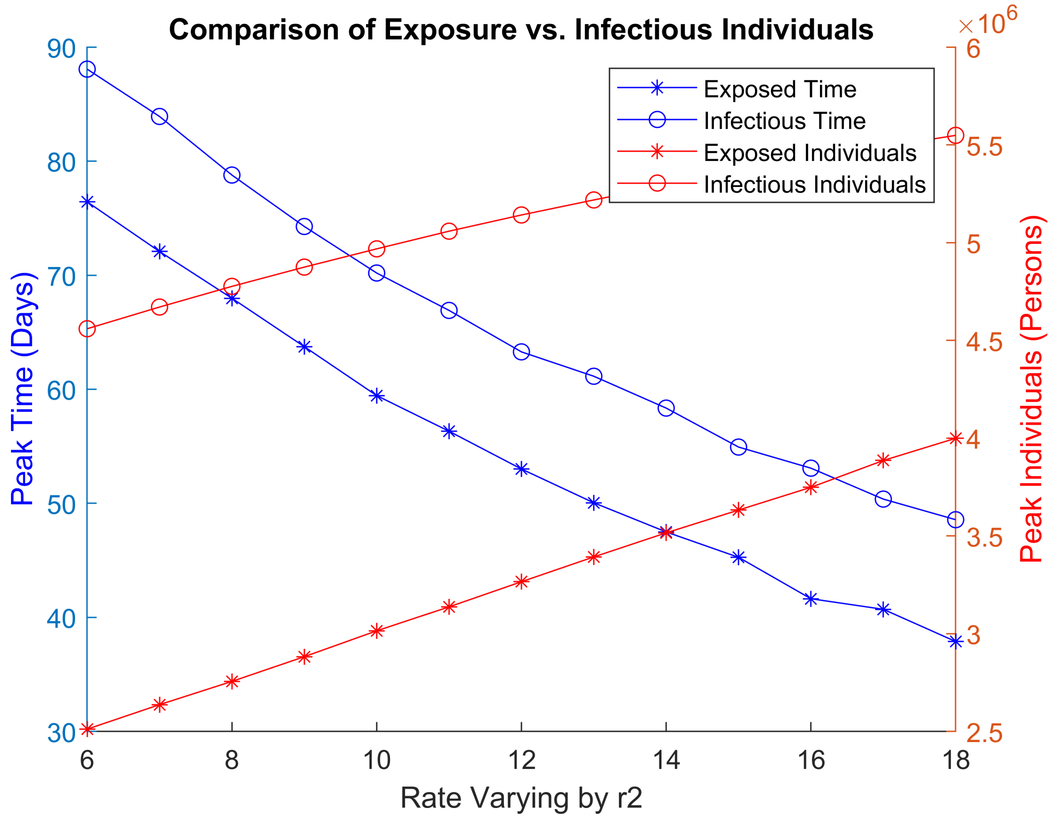


Table Creation of Comparison of Time and Proportions over Different r2 Rates

```
% Create a table of the r2 values with their respective peak time for both
% exposed and infectious individuals
TableProportions = table(rate_varying', times(2,:)', (maxima(2,:)')./11081000, times(3,:)', (ma
```

```
TableProportions = 13×5 table
```

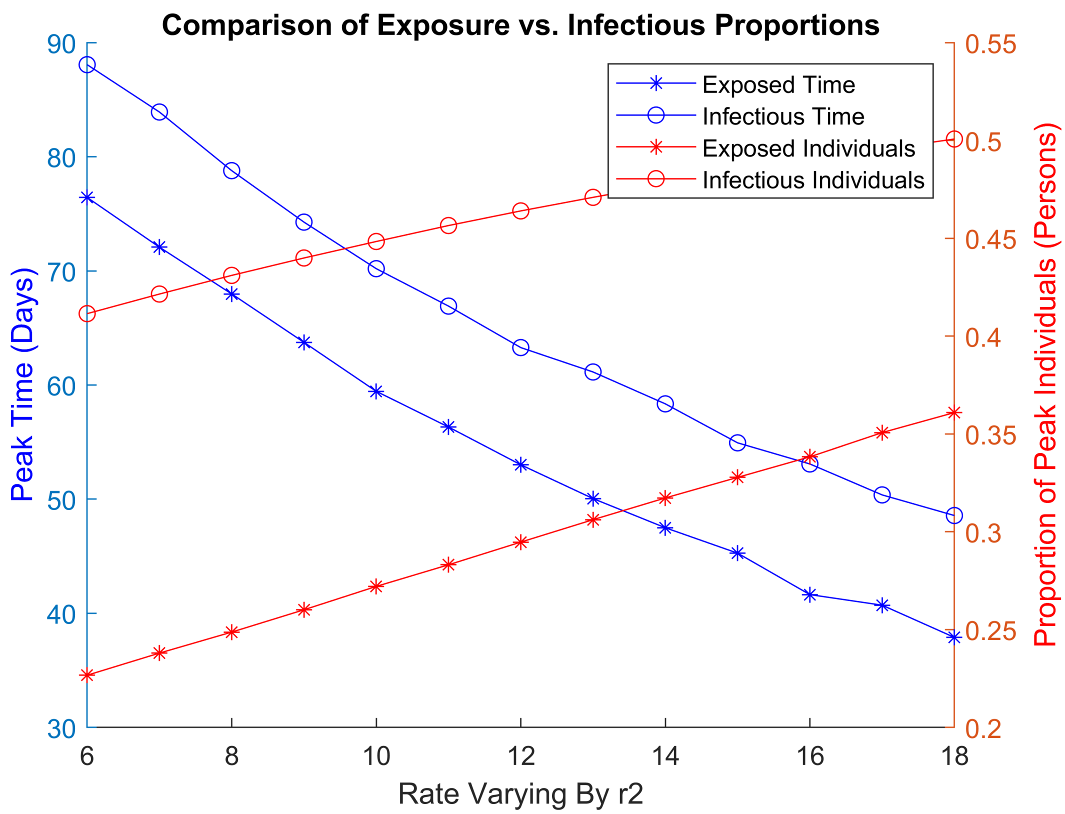
...

	r2	Peak Time (Days) for Exposed Individuals	Peak Exposed Individuals
1	6	76.4320	0.2267
2	7	72.0765	0.2380
3	8	67.9799	0.2487
4	9	63.7391	0.2601
5	10	59.4497	0.2721
6	11	56.3213	0.2831
7	12	53.0115	0.2947
8	13	50.0505	0.3062
9	14	47.4949	0.3173
10	15	45.2694	0.3278
11	16	41.6390	0.3383
12	17	40.7125	0.3507

	r2	Peak Time (Days) for Exposed Individuals	Peak Exposed Individuals
13	18	37.8889	0.3609

Comparison of Exposure vs. Infectious Individuals for Basic Model (Proportions)

```
% New figure
figure

% Hold on
hold on

% On left y-axis
yyaxis left

% Plot times
plot(rate_varying', times(2,:)', '-b*', rate_varying', times(3,:)', '-bo')

% Add labels for axes
xlabel('Rate Varying By r2')
ylabel('Peak Time (Days)', 'Color', 'b')

% Add title
title('Comparison of Exposure vs. Infectious Proportions')

% On right y-axis
yyaxis right

% Plot proportions
plot(rate_varying', (maxima(2,:)')./11081000, '-r*', rate_varying', (maxima(3,:)')./11081000,

% Add y-label
ylabel('Proportion of Peak Individuals (Persons)', 'Color', 'r')

% Add legend
legend('Exposed Time', 'Infectious Time', 'Exposed Individuals', 'Infectious Individuals')
```



Contact Network Simulation

This .mlx file establishes a radonmized contact network matrix that attempts to simulate the transmission of covid-19 amongst susceptible, infected, exposed, hospitalized, deceased, and recovered individuals. A parametric analysis is performed with respect to the level of social distancing/isolating or quarantining that occurs while susceptible.

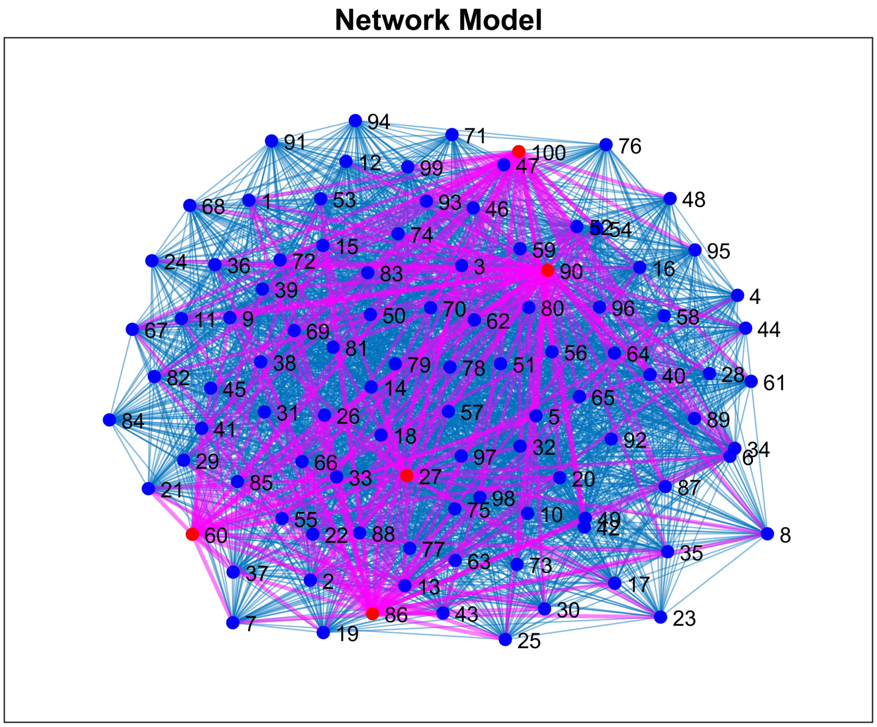
Generate Basic Results from SEIR Model for later graphing/comparison with the network model

```
%% Basic Model Implementation
% Input for ode45 function
input_vector = [11080778 193 27 2]; % [Susceptible, Exposed, Infectious, Recovered]
time = [0 365]; % days

% Ode45 function for transmission approximation
[T,Y] = ode45(@basic_model, time, input_vector);
```

Step 1. Set up Network Representation

```
% Number of individuals
N = 100;

% Random symmetric matrix
network = randi([0, 1], N);
network = triu(network, 1);
network = network + network';
```

```
% Initialize the state of individuals (0 = Susceptible, 1 = Infected)
state = zeros(N, 1);

% Create random ages for individuals in contact network
age = ones(N,1);
for p = 1:size(age,1)
    age(p) = randi(80);
end

% Randomly assign a few individuals as Infected
num_initially_infected = 0.05*N;
infected_indices = randperm(N, num_initially_infected);
state(infected_indices) = 1;

% Initial stats:
initial_infected_proportion = sum(state)/N;
initial_susceptible_proportion = sum(state==0)/N;

G = graph(network, 'upper'); % Create a graph object

% Assign states to nodes in the graph
for i = 1:N
    if state(i) == 0
        G.Nodes.State{i} = 'Susceptible';
    else
        G.Nodes.State{i} = 'Infected';
    end
end

% Plot the graph
figure;
p = plot(G, 'Layout', 'force');
susceptibleNodes = find(state==0); % Susceptible individuals
infectedNodes = find(state==1); % Infected individuals
highlight(p, susceptibleNodes, 'NodeColor', 'blue'); % Blue nodes for susceptible individuals
highlight(p, infectedNodes, 'NodeColor', 'red'); % Red nodes for infected individuals
connections = G.Edges.EndNodes;
susceptible_infected_edges = connections(ismember(state(connections(:, 1)), 0) & ismember(state
highlight(p, susceptible_infected_edges(:, 1), susceptible_infected_edges(:, 2), 'EdgeColor', '
title('Network Model');
```



Step 2. Simulate

```
% CUSTOMIZE PARAMETERS %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
num_days = 365;                                     % days
expose_prob = 0.05;                                 % exposure prob
infect_prob = 0.04;                                 % infection prob (4% was given in paper)
recover_prob = 0.1;                                 % recovery prob
num_exposed = zeros(num_days, 1);                   % Vector of exposed individuals each day
num_infected = zeros(num_days, 1);                  % Vector of infected individuals each day
hospitalization_rate = 0.15;                        %https://gis.cdc.gov/grasp/COVIDNet/COVID19_3.h
socialdist_prob = [0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1];  % no statistic for social distanc

% Hosp death rate approximated where the weekly peaks were averaged from:
% https://www.cdc.gov/nchs/covid19/nhcs/hospital-mortality-by-week.htm
hosp_death_rate_29 = 0.03/7;
hosp_death_rate_59 = 0.07/7;
hosp_death_rate_plus = 0.18/7;
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Iterative Contacts and Transmission Approximation

```
% Store infected/susceptible state to recall for all iterations
state_orig = state;

% RECAP: SUSCEPTIBLE = 0, INFECTED = 1, EXPOSED = 2, HOSPITALIZED = 3,
```

```
% RECOVERED/IMMUNE = 4, DEAD = NaN

% For each potential social distancing probability
for c = 1:11

    % Repeat model for 100 iterations to average findings
    for l = 1:100

        % initialize the iteration state of susceptible and infected to original state of infec
        state = state_orig;

        % For each day in the year
        for day = 1:num_days

            % For each individual in the contact network
            for i = 1:N

                % If the individual is infected
                if state(i) == 1

                    % Find the other individuals in the network they are in
                    % contact with
                    contacts = find(network(i, :));

                    % For all contacts in network
                    for j = contacts

                        % Randomly generate a number to decide chance of
                        % contact becoming exposed if susceptible
                        exposed_diceroll = rand;

                        % If contact is susceptible
                        if state(j) == 0

                           % generate random chance for not social distancing
                           social_dist_diceroll = rand;

                           % If individual didn't social distance
                           if social_dist_diceroll > socialdist_prob(c)

                                % See if the probability is within the expected for
                                % exposure
                                if exposed_diceroll < expose_prob

                                    % If so, susceptible individual becomes exposed
                                    % to COVID
                                    state(j) = 2;
                                end
                           end
                        end
```

```
            end

            % now move onto the current infected patient

            % Since the patient is infected, there is a chance they
            % will recover

            % Randomly generate this chance
            recovery_diceroll = rand;

            % Randomly generate a chance for hospitalization as well
            hospitalized_diceroll = rand;
            % IMMUNITY LASTS ABOUT 500 DAYS (well within sim) https://www.medicalnewsto
            % If recovery chance is within expected probability
            if recovery_diceroll < recover_prob

                % Infected individual becomes susceptible again
                % (disregard short-term immunity as individuals have
                % been found to get covid multiple times)
                state(i) = 4;

            % if chance not within recovery and hospitalization is
            % probable
            elseif recovery_diceroll > recover_prob && hospitalized_diceroll < hospital

                % infected individual instead becomes hospitalized
                state(i) = 3;
            end

        % If the individual is not infected, but is exposed,
        elseif state(i) == 2

            % Generate random chance for individual to become infected
            infected_diceroll = rand;

            % If chance is within expected
            if infected_diceroll <  infect_prob

                % Convert exposed individual to infected
                state(i) = 1;
            end

        % If individual is hospitalized
        elseif state(i) == 3

            % Generate random recovery chance
            recovery_diceroll = rand;

            % Generate random hospitalization chance
            hospitalized_diceroll = rand;
```

```
                % Generate random death chance
                reaper_diceroll = rand;

                % IMMUNITY FOR 500 days (well within sim) https://www.medicalnewstoday.com/
                % If recovery is expected
                if recovery_diceroll < recover_prob

                    % Hospitalized individual becomes susceptible and can
                    % go home
                    state(i) = 4;

                % If individual is still symptomatic and expected by chance
                elseif hospitalized_diceroll < hospitalization_rate

                    % Remain in hospital
                    state(i) = 3;
                end

                % If the individual's age is less than or equal to 29
                if age(i) <= 29

                    % Evaluate death roll vs. hospital death rate for
                    % this age range
                    if reaper_diceroll < hosp_death_rate_29

                        % Remove from matrix as deceased
                        state(i) = NaN;
                    end

                % elseif the individual's age is less than or equal to
                % 59
                elseif age(i) <= 59
                    % Evaluate death roll vs. hospital death rate for
                    % this age range
                    if reaper_diceroll < hosp_death_rate_59

                        % Remove from matrix as deceased
                        state(i) = NaN;
                    end

                % else the individual's age is considered > 59
                else

                    % Evaluate death roll vs. hospital death rate for
                    % this age range
                    if reaper_diceroll < hosp_death_rate_plus

                        % Remove from matrix as deceased
                        state(i) = NaN;
```

```
                    end
                end

            % If susceptible,
            elseif state(i) == 0
                social_dist_diceroll = rand;
                if social_dist_diceroll > socialdist_prob(c) % then did not social distance
                    state(i) = 2;
                end
            end
        end

        % Record the number of exposed and infected individuals
        num_susceptible(day) = sum(state == 0);
        num_infected(day) = sum(state == 1);
        num_exposed(day) = sum(state == 2);
        num_hospitalized(day) = sum(state == 3);
        num_immune(day) = sum(state == 4);
        num_deceased(day) = sum(isnan(state));
    end

% Store all of the simulated data for this iteration in the accumulation
% variables
num_exposed_accumulated(l,:) = num_exposed';
num_infected_accumulated(l,:) = num_infected';
num_susceptible_accumulated(l,:) = num_susceptible';
num_deceased_accumulated(l,:) = num_deceased';
num_hospitalized_accumulated(l,:) = num_hospitalized';
num_immune_accumulated(l, :) = num_immune';
end

% For the average quarantining/social distancing rate of 0.5, when c
% == 6
if c == 6

    % Display a message about the upcoming figure
    fprintf('This figure displays the maxima along the \nmean of 10 simulation iterations f

    % Plot the number of exposed and infected individuals over time
    figure;

    % Plot susceptible
    plot(0:num_days, [initial_susceptible_proportion mean(num_susceptible_accumulated)/N],
    hold on
    % Plot exposed proportion
    plot(0:num_days, [0 mean(num_exposed_accumulated)/N], 'Color', 'Blue', 'DisplayName', '

    % Plot infectious proportion
    plot(0:num_days, [initial_infected_proportion mean(num_infected_accumulated)/N], 'Color
```

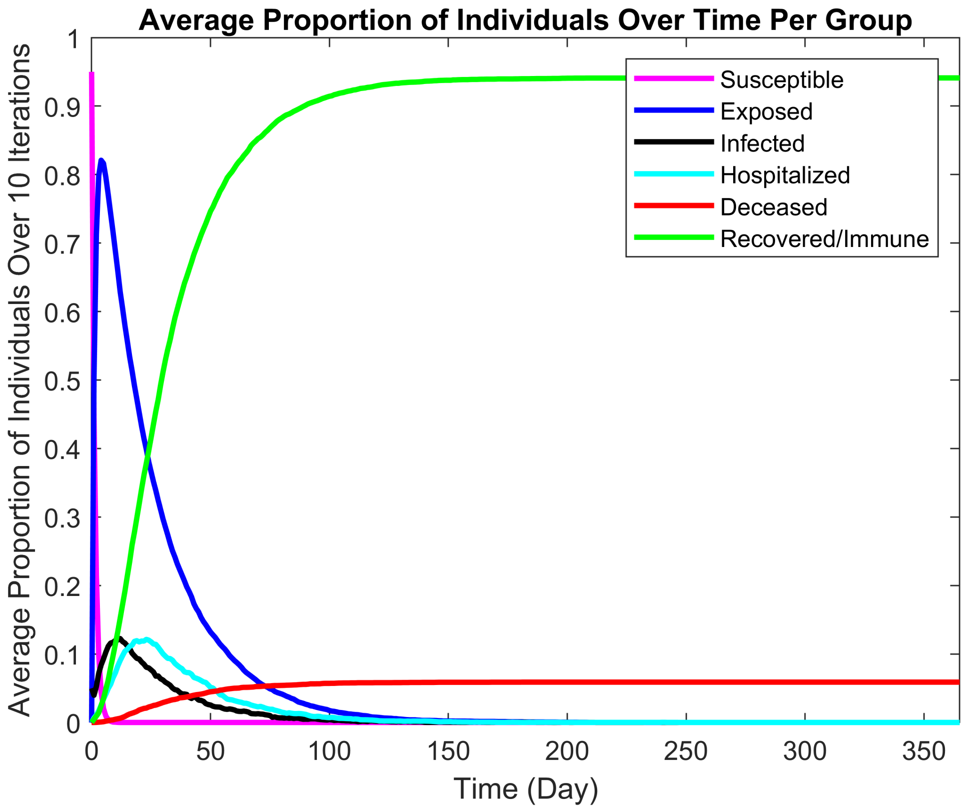
```
% Plot hospitalized proportion
plot(0:num_days, [0 mean(num_hospitalized_accumulated)/N], 'Color', 'Cyan', 'DisplayNar

% Plot deceased proportion
plot(0:num_days, [0 mean(num_deceased_accumulated)/N], 'Color', 'Red', 'DisplayName', 

% Plot immune proportion
plot(0:num_days, [0 mean(num_immune_accumulated)/N], 'Color', 'Green', 'DisplayName', 
% Label figure
xlabel('Time (Day)');
ylabel('Average Proportion of Individuals Over 10 Iterations');
xlim([0 num_days])
title('Average Proportion of Individuals Over Time Per Group')
legend()

% Hold off of the figure
hold off

% Next we will generate subplots for the comparison of the network
% model to the SEIR model
figure
hold on

% Susceptible subplot
subplot(3,2,1)
hold on

% Plot network results
plot(0:num_days, [initial_susceptible_proportion mean(num_susceptible_accumulated)/N],

% Plot SEIR results
plot(T,Y(:,1)./11081000, 'LineWidth', 2, 'DisplayName', 'SEIR @ r2=18')

% Label figure
ylabel('Proportion of Total')
title('Susceptible')
xlabel('Time (Days)')
ylim([0 1])
legend

% Exposed subplot
subplot(3,2,2)
hold on

% Plot network results
plot(0:num_days, [0 mean(num_exposed_accumulated)/N], 'DisplayName', 'Network', 'LineWi

% Plot SEIR results
plot(T,Y(:,2)./11081000, 'LineWidth', 2, 'DisplayName', 'SEIR @ r2=18')
```

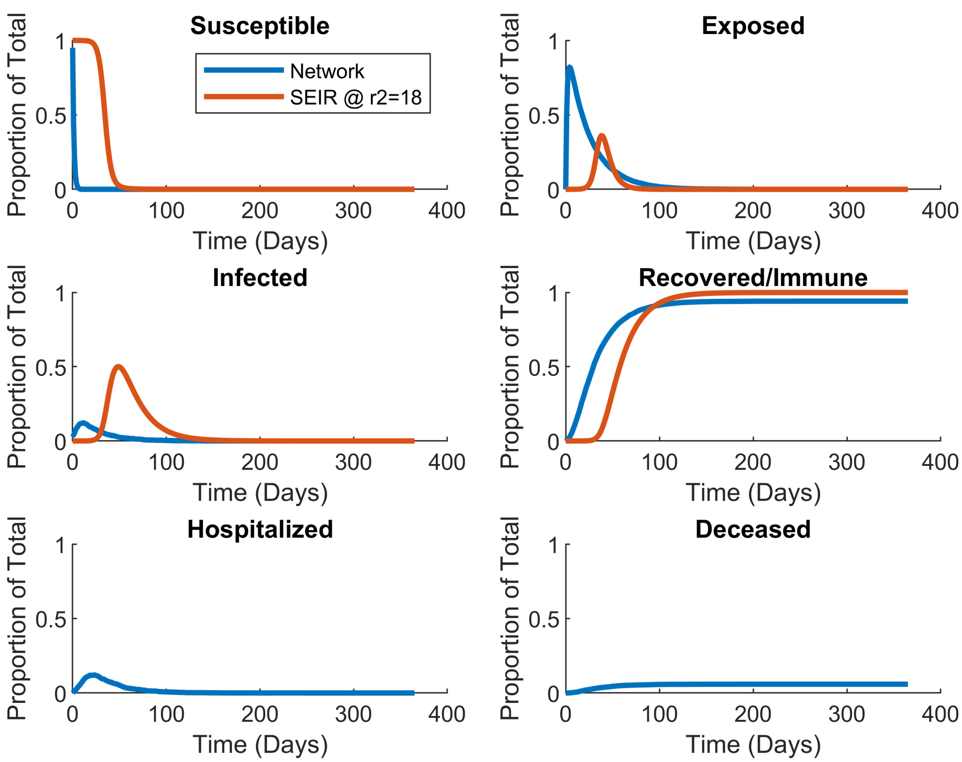
```
        % Label figure
        ylabel('Proportion of Total')
        title('Exposed')
        xlabel('Time (Days)')
        ylim([0 1])

        % Infected subplot
        subplot(3,2,3)
        hold on

        % Plot network results
        plot(0:num_days, [initial_infected_proportion mean(num_infected_accumulated)/N],'Displa

        % Plot SEIR results
        plot(T,Y(:,3)./11081000, 'LineWidth', 2, 'DisplayName', 'SEIR @ r2=18')

        % Label figure
        ylabel('Proportion of Total')
        title('Infected')
        xlabel('Time (Days)')
        ylim([0 1])

        % Recovered subplot
        subplot(3,2,4)
        hold on

        % Plot network results
        plot(0:num_days, [0 mean(num_immune_accumulated)/N], 'DisplayName', 'Network', 'LineWid

        % Plot SEIR results
        plot(T,Y(:,4)./11081000, 'LineWidth', 2, 'DisplayName', 'SEIR @ r2=18')

        % Label figure
        ylabel('Proportion of Total')
        title('Recovered/Immune')
        xlabel('Time (Days)')
        ylim([0 1])

        % Hospitalized subplot
        subplot(3,2,5)
        hold on

        % Plot network results
        plot(0:num_days, [0 mean(num_hospitalized_accumulated)/N], 'DisplayName', 'Network', 'L

        % Label figure
        ylabel('Proportion of Total')
        title('Hospitalized')
        xlabel('Time (Days)')
        ylim([0 1])
```

```
    % Deceased Subplot
    subplot(3,2,6)
    hold on

    % Network results
    plot(0:num_days, [0 mean(num_deceased_accumulated)/N], 'DisplayName', 'Network', 'LineW

    % Label figure
    ylabel('Proportion of Total')
    title('Deceased')
    xlabel('Time (Days)')
    ylim([0 1])

end

% Calculate Average for each iteration

% Mean Peak Susceptible
avg_susceptible = mean(num_susceptible_accumulated);
% Mean Peak Exposed
avg_exposed = mean(num_exposed_accumulated);
% Mean Peak Infected
avg_infected = mean(num_infected_accumulated);
% Mean Peak Deceased
avg_deceased = mean(num_deceased_accumulated);
% Mean Peak Hospitalized
avg_hospitalized = mean(num_hospitalized_accumulated);
% Mean Peak Immune
avg_immune = mean(num_immune_accumulated);

% Calculuate maximum of average of each iteration

% Susceptible
max_susceptible = max(avg_susceptible);
% Exposed
max_exposed = max(avg_exposed);
% Infected
max_infected = max(avg_infected);
% Deceased
max_deceased = max(avg_deceased);
% Hospitalized
max_hospitalized = max(avg_hospitalized);
% Immune
max_immune = max(avg_immune);

% Find times corresponding with maxima

% Susceptible
time_susceptible = find(avg_susceptible == max_susceptible);
```

```
    % Exposed
    time_exposed = find(avg_exposed == max_exposed);
    % Infected
    time_infected = find(avg_infected == max_infected);
    % Deceased
    time_deceased = find(avg_deceased == max_deceased);
    % Hospitalized
    time_hospitalized = find(avg_hospitalized == max_hospitalized);
    % Immune
    time_immune = find(avg_immune == max_immune);

    % Concatenate the results for the quarantining rate iteartion
    max_c(:,c) =[max_susceptible/N;max_exposed/N; max_infected/N; max_deceased/N; max_hospitali
    time_c(:,c) = [time_susceptible(1); time_exposed(1);time_infected(1); time_deceased(1); tin

    % For quarantining rate = 0.5, display a table of results
    if c == 6
        fprintf('This table displays the maxima along the \nmean of 10 simulation iterations fo
        t1 = table([max_susceptible/N; time_susceptible(1)], [max_exposed/N; time_exposed(1)],
        t1.Properties.VariableNames = {'Max Susceptible', 'Max Exposed', 'Max Infected', 'Max D
        t1.Properties.RowNames = {'Proportions Across Simulation', 'Times for Max Average Propo
        disp(t1)
    end
end
```

```
This figure displays the maxima along the
mean of 10 simulation iterations for each group
and the times in which they occur
for quarantining rate of 0.5.
```





This table displays the maxima along the
mean of 10 simulation iterations for each group
and the times in which they occur
for quarantining rate of 0.5.

	Max Susceptible	Max Exposed	Max Infected	Max Deceased	Max Hospi
Proportions Across Simulation	0.4454	0.8209	0.1225	0.0589	0.12
Times for Max Average Proportions	1	4	12	181	

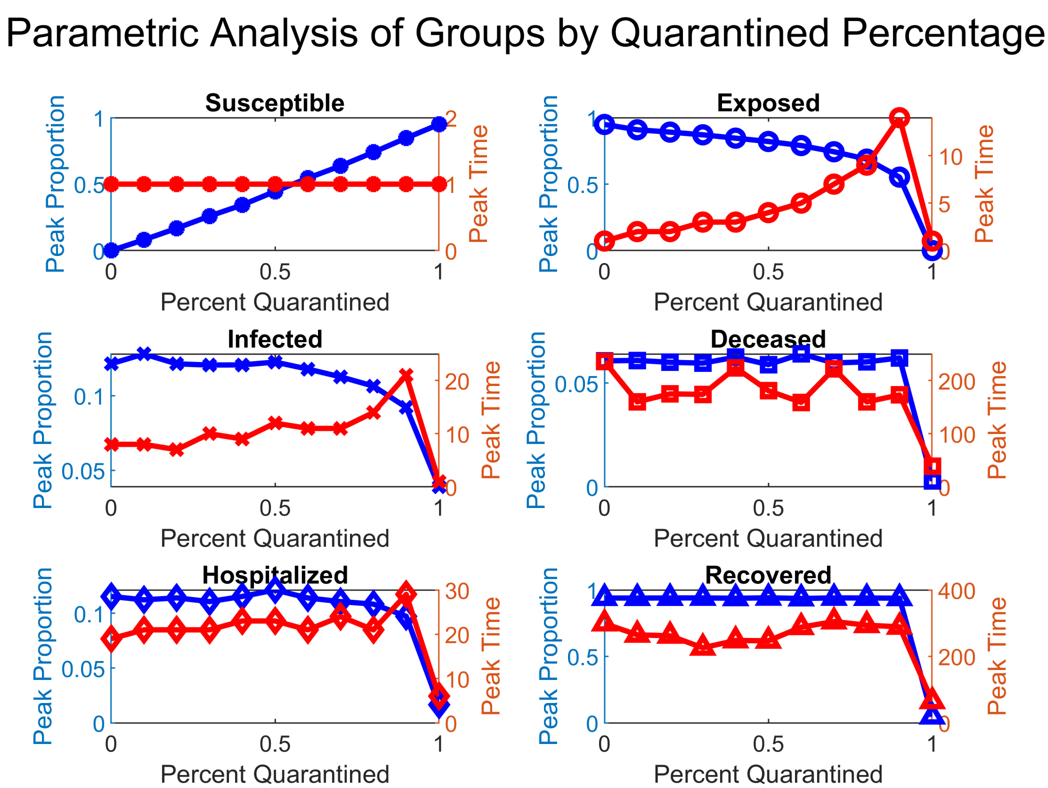
Step 3. Parametric Analysis by Social Distancing/Isolating/Quaranting

Separated groups across quarantining rate

```
% Generate a new figure
figure

% Give it an overarching title
sgtitle('Parametric Analysis of Groups by Quarantined Percentage')
hold on

% For each subgroup
for k = 1:6

    % If susceptible
    if k == 1

        % First subplot
        subplot(3,2,1)

        % On left y-axis
        yyaxis left

        % Plot peak proportion
        plot(socialdist_prob, max_c(k,:), '-b*', 'LineWidth', 2,'DisplayName', 'Susceptible')
        ylabel('Peak Proportion')

        % On right y-axis
        yyaxis right

        % Plot peak time in days
        plot(socialdist_prob, time_c(k,:),'-r*','LineWidth', 2, 'DisplayName', 'Susceptible')
        xlabel('Percent Quarantined')
        ylabel('Peak Time')

        % Add title
        title('Susceptible')

    % If exposed
    elseif k == 2

        % Second subplot
        subplot(3,2,2)

        % On left y-axis
```

```
        yyaxis left

        % Plot peak proportion
        plot(socialdist_prob, max_c(k,:), '-bo','LineWidth', 2,'DisplayName', 'Exposed')
        ylabel('Peak Proportion')

        % On right y-axis
        yyaxis right

        % Plot peak time
        plot(socialdist_prob, time_c(k,:),'-ro', 'LineWidth', 2, 'DisplayName', 'Exposed')
        xlabel('Percent Quarantined')
        ylabel('Peak Time')

        % Add title
        title('Exposed')

    % If infected, follow similar commenting
    elseif k == 3
        subplot(3,2,3)
        yyaxis left
        plot(socialdist_prob, max_c(k,:), '-bx','LineWidth', 2,'DisplayName', 'Infected')
        ylabel('Peak Proportion')
        yyaxis right
        plot(socialdist_prob, time_c(k,:), '-rx','LineWidth', 2, 'DisplayName', 'Infected')
        xlabel('Percent Quarantined')
        ylabel('Peak Time')
        title('Infected')

    % If deceased, follow similar commenting
    elseif k == 4
        subplot(3,2,4)
        yyaxis left
        plot(socialdist_prob, max_c(k,:), '-bs','LineWidth', 2,'DisplayName', 'Diseased')
        ylabel('Peak Proportion')
        yyaxis right
        plot(socialdist_prob, time_c(k,:), '-rs','LineWidth', 2, 'DisplayName', 'Diseased')
        xlabel('Percent Quarantined')
        ylabel('Peak Time')
        title('Deceased')

    % If Hospitalized, follow similar commenting
    elseif k == 5
        subplot(3,2,5)
        yyaxis left
        plot(socialdist_prob, max_c(k,:), '-bd','LineWidth', 2,'DisplayName', 'Hospitalized')
        ylabel('Peak Proportion')
        yyaxis right
        plot(socialdist_prob, time_c(k,:), '-rd','LineWidth', 2, 'DisplayName', 'Hospitalized')
        xlabel('Percent Quarantined')
```

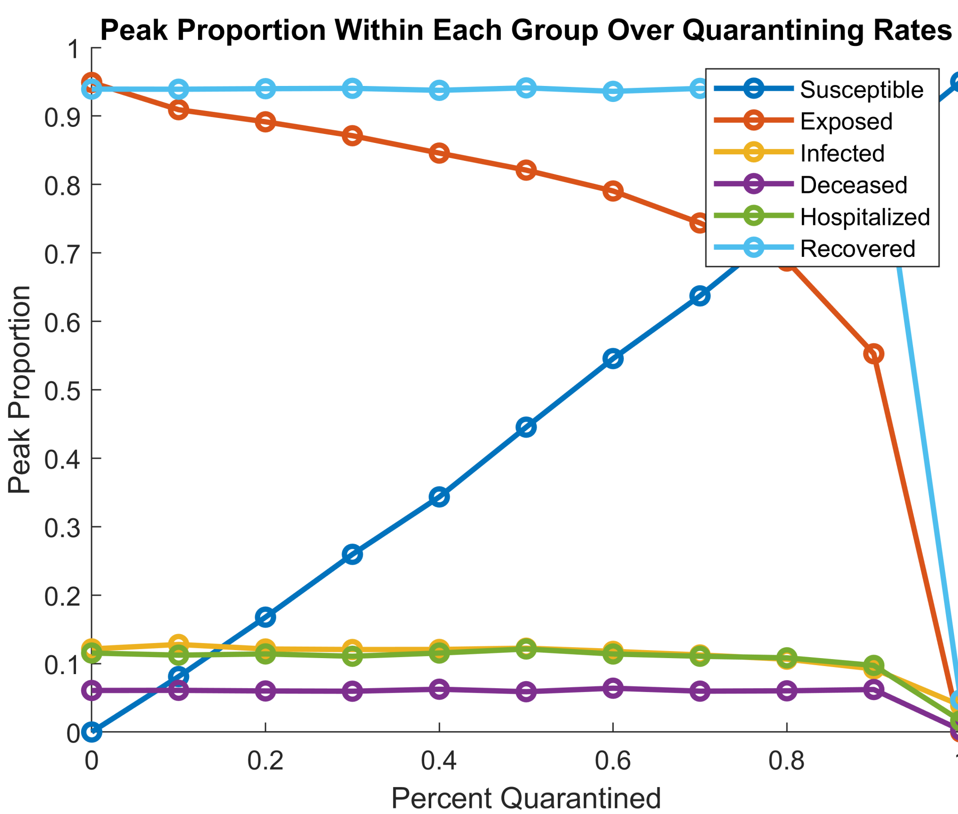
```
        ylabel('Peak Time')
        title('Hospitalized')

    % If recovered, follow similar commenting
    elseif k == 6
        subplot(3,2,6)
        yyaxis left
        plot(socialdist_prob, max_c(k,:), '-b^','LineWidth', 2,'DisplayName', 'Recovered')
        ylabel('Peak Proportion')
        yyaxis right
        plot(socialdist_prob, time_c(k,:), '-r^','LineWidth', 2, 'DisplayName', 'Recovered')
        xlabel('Percent Quarantined')
        ylabel('Peak Time')
        title('Recovered')
    end
end
```



Peak proportions across quarantining rates

```
% New figure
figure
hold on

% Plot all groups over quarantining rates
for k = 1:6
    if k == 1
        plot(socialdist_prob, max_c(k,:), '-o','LineWidth', 2,'DisplayName', 'Susceptible')
```

```
    elseif k == 2
        plot(socialdist_prob, max_c(k,:),'-o', 'LineWidth', 2,'DisplayName', 'Exposed')
    elseif k == 3
        plot(socialdist_prob, max_c(k,:),'-o', 'LineWidth', 2,'DisplayName', 'Infected')
    elseif k == 4
        plot(socialdist_prob, max_c(k,:),'-o', 'LineWidth', 2,'DisplayName', 'Deceased')
    elseif k == 5
        plot(socialdist_prob, max_c(k,:),'-o', 'LineWidth', 2,'DisplayName', 'Hospitalized')
    elseif k == 6
        plot(socialdist_prob, max_c(k,:), '-o', 'LineWidth', 2,'DisplayName', 'Recovered')
    end
end

% Label figure
xlabel('Percent Quarantined')
legend
ylabel('Peak Proportion')
title('Peak Proportion Within Each Group Over Quarantining Rates')
hold off
```



Times at peak proportions across quarantining rates

```
% New figure
figure
hold on
```

```
% For each group, plot time at peak proportion with similar commenting
for k = 1:6
    if k == 1
        plot(socialdist_prob, time_c(k,:), '-o','LineWidth', 2, 'DisplayName', 'Susceptible')
    elseif k == 2
        plot(socialdist_prob, time_c(k,:),'-o', 'LineWidth', 2, 'DisplayName', 'Exposed')
    elseif k == 3
        plot(socialdist_prob, time_c(k,:), '-o','LineWidth', 2, 'DisplayName', 'Infected')
    elseif k == 4
        plot(socialdist_prob, time_c(k,:), '-o','LineWidth', 2, 'DisplayName', 'Deceased')
    elseif k == 5
        plot(socialdist_prob, time_c(k,:), '-o','LineWidth', 2, 'DisplayName', 'Hospitalized')
    elseif k == 6
        plot(socialdist_prob, time_c(k,:), '-o','LineWidth', 2, 'DisplayName', 'Recovered')
    end
end
xlabel('Percent Quarantined')
legend
ylabel('Time for Peak Proportion')
title('Time @ Peak Proportion Over Quarantining Rates')
```