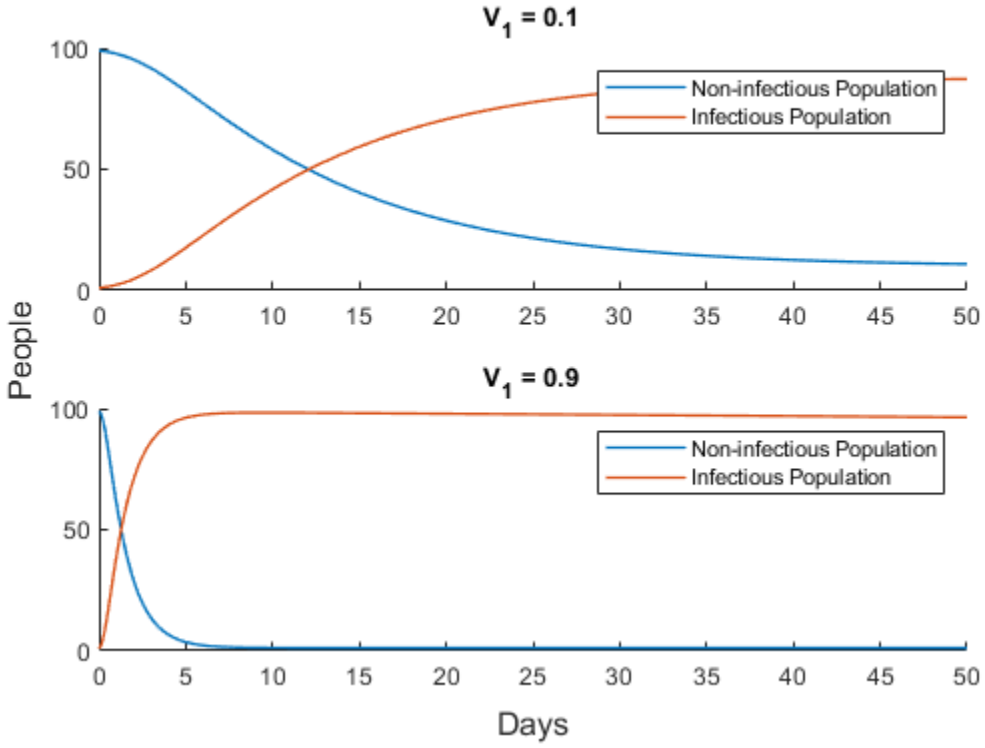
```
clear,clc
% Parameter Values
V1 = [0.1 0.9]; % infection rate
K1 = [10 30]; % saturation constant for infection
r = [0.1 0.9]; % recovery rate
alpha = [0.01 0.1]; % rate of reinfection
K2 = 100; % saturation constant for recovery
x0 = [99 1]; % initial conditions
tspan = [0 50]; % length of time of simulation

% VARYING V_1
figure();
tl = tiledlayout(2,1);
xlabel(tl, "Days");
ylabel(tl, "People");
title(tl, "Simulation of Uncontrolled Epidemic Model with Low and High
Infection Rates")
for (i = 1:length(V1))
    params = [V1(i) K1(1) K2 r(1) alpha(1)];
    [t,x] = ode45(@(t,x) sem(t,x,params), tspan, x0);
    nexttile;
    hold on;
    plot(t,x(:,1),"LineWidth",1);
    plot(t,x(:,2),"LineWidth",1);
    legend("Non-infectious Population", "Infectious Population");
    title("V_1 = " + V1(i))
    hold off;
end

% VARYING K_1
figure();
tl = tiledlayout(2,1);
xlabel(tl, "Days");
ylabel(tl, "People");
title(tl, "Simulation of Uncontrolled Epidemic Model for Varying Saturation
Constant (Infection)");
for (i = 1:length(K1))
    params = [V1(1) K1(i) K2 r(1) alpha(1)];
    [t,x] = ode45(@(t,x) sem(t,x,params), tspan, x0);
    nexttile;
    hold on;
    plot(t,x(:,1),"LineWidth",1);
    plot(t,x(:,2),"LineWidth",1);
    legend("Non-infectious (sem)", "Infectious (sem)");
    title("K_1 = " + K1(i))
    hold off;
end

% VARYING r
tspan = [0 250]; % difficult to ascertain differences in shorter time
simulation
figure();
```

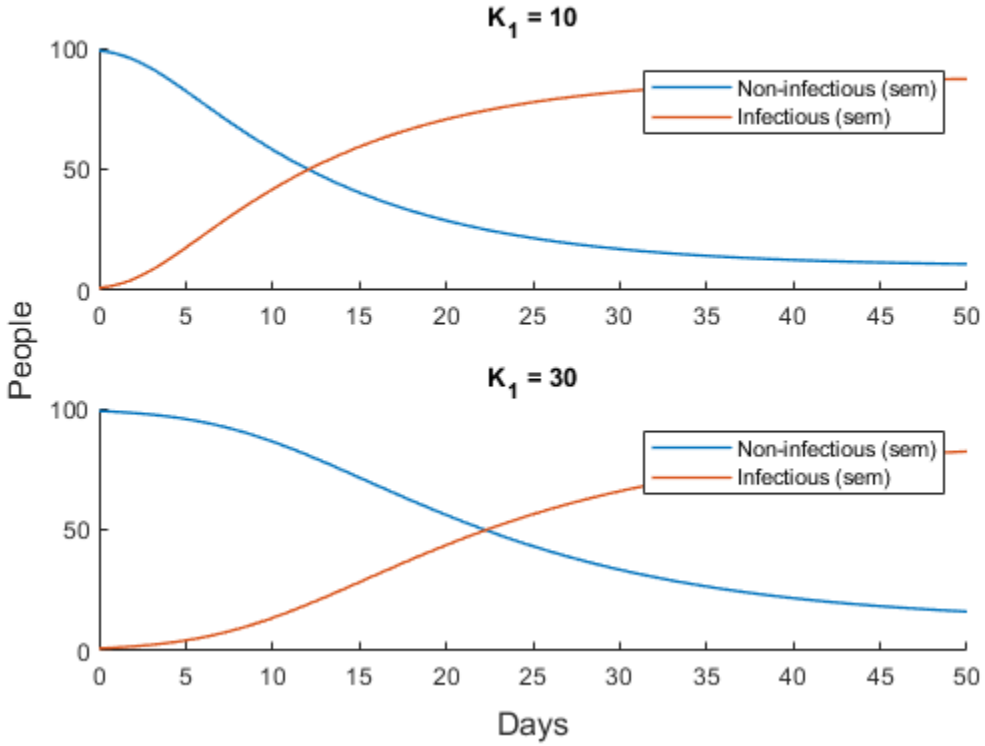
```
tl = tiledlayout(2,1);
xlabel(tl, "Days");
ylabel(tl, "People");
title(tl, "Simulation of Uncontrolled Epidemic Model for Low and High
Recovery Rates")
for (i = 1:length(r))
    params = [V1(1) K1(1) K2 r(i) alpha(1)];
    [t,x] = ode45(@(t,x) sem(t,x,params), tspan, x0);
    nexttile;
    hold on;
    plot(t,x(:,1),"LineWidth",1);
    plot(t,x(:,2),"LineWidth",1);
    legend("Non-infectious", "Infectious");
    title("r = " + r(i))
    hold off;
end
tspan = [0 50]; % reset tspan

% VARYING alpha
figure();
tl = tiledlayout(2,1);
xlabel(tl, "Days");
ylabel(tl, "People");
title(tl, "Simulation of Uncontrolled Epidemic Model with Varying Re-
Infection Rates")
for (i = 1:length(alpha))
    params = [V1(1) K1(1) K2 r(1) alpha(i)];
    [t,x] = ode45(@(t,x) sem(t,x,params), tspan, x0);
    nexttile;
    hold on;
    plot(t,x(:,1),"LineWidth",1);
    plot(t,x(:,2),"LineWidth",1);
    legend("Non-infectious Population", "Infectious Population");
    title("\alpha = " + alpha(i))
    hold off;
end
tspan = [0 50];
x0 = [98 2]; % for \alpha = 0.3, the linearized dynamics are hard to see
with x0 = [99 1]
V1 = 0.1;
K1 = 10;
r = 0.1;
K2 = 100;
alpha = [0.001 0.3];

figure();
tl = tiledlayout(2,2);
xlabel(tl, "Time");
ylabel(tl, "Population");
title(tl, "Comparison of Linearized Model to True Nonlinear Dynamics")
for (i = 1:length(alpha))
    if (i == 2)
        tspan = [0 10]; % shorter time simulation for \alpha = 0.3 because
linearized model shows little change
```

```
    end
    params = [V1 K1 K2 r alpha(i)];
    [t,x] = ode45(@(t,x) sem(t,x,params), tspan, x0);
    nexttile;
    hold on;
    plot(t,x(:,1),"LineWidth",1);
    plot(t,x(:,2),"LineWidth",1);
    legend("Non-infectious", "Infectious");
    title("Nonlinear Model with \alpha = " + alpha(i));
    hold off;
    [t,x] = ode45(@(t,x) lin(t,x,params), tspan, x0);
    nexttile;
    hold on;
    plot(t,x(:,1),"LineWidth",1);
    plot(t,x(:,2),"LineWidth",1);
    legend("Non-infectious", "Infectious");
    title("Linearized Model with \alpha = " + alpha(i));
    hold off;
end
% params = [V1 K1 K2 r alpha]
function dxdt = sem(t,x,params) % no input simplified epidemic model
dxdt = [-(params(1)*x(1)*x(2))/(params(2)+x(2)) + params(5)*x(2);
    (params(1)*x(1)*x(2))/(params(2)+x(2)) - (params(4)*x(2))/(x(2) +
params(3)) - params(5)*x(2)];
end

function dxdt = lin(t,x,params) % linearized model around (x_{e1},0)
A = [0 params(5)-(1/params(2));
    0 (1/params(2))-(params(4)/params(3))-params(5)];
dxdt = A*x;
end
```

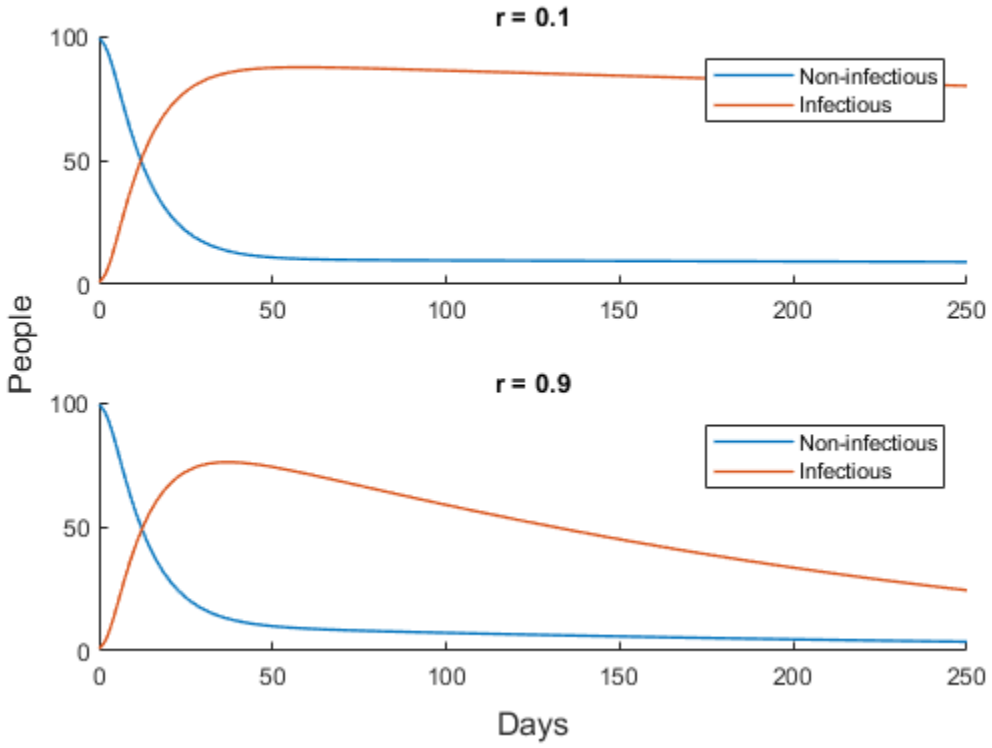
Simulation of Uncontrolled Epidemic Model with Low and High Infection Ra



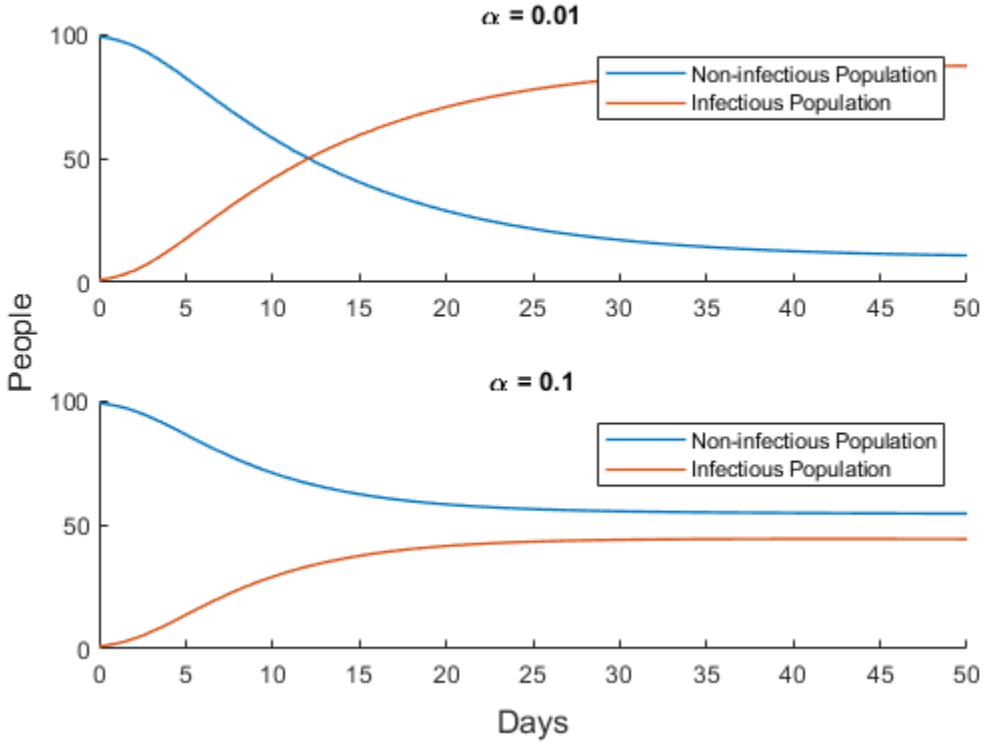
lation of Uncontrolled Epidemic Model for Varying Saturation Constant (In

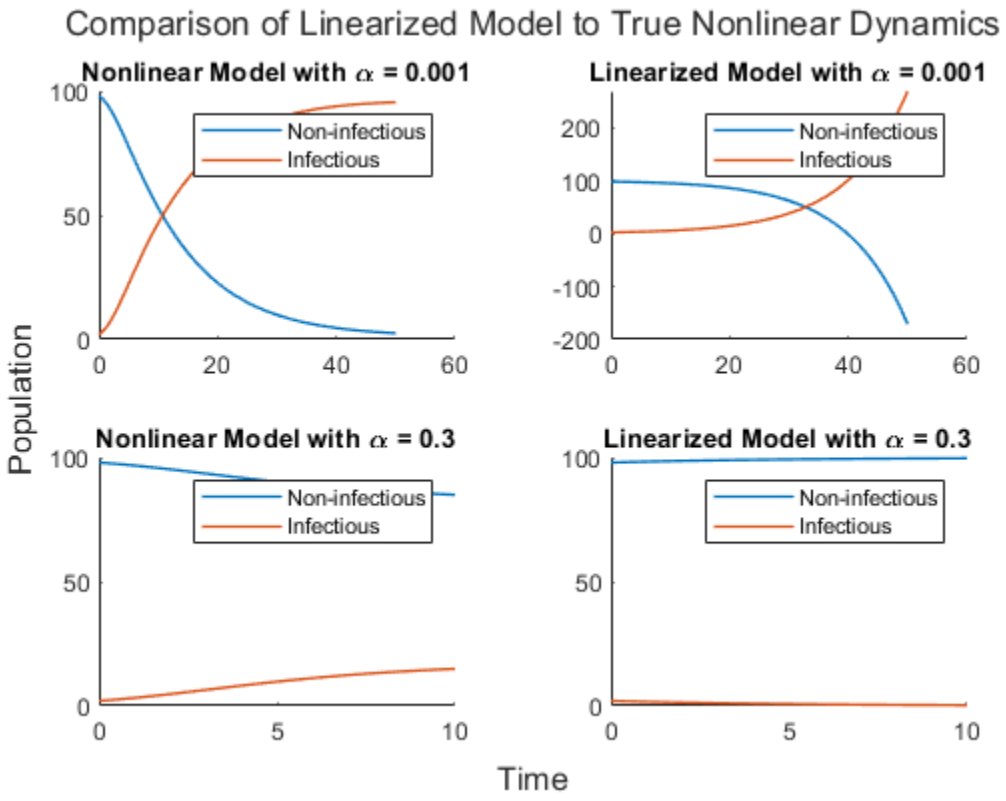


Simulation of Uncontrolled Epidemic Model for Low and High Recovery Ra



Simulation of Uncontrolled Epidemic Model with Varying Re-Infection Rat





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