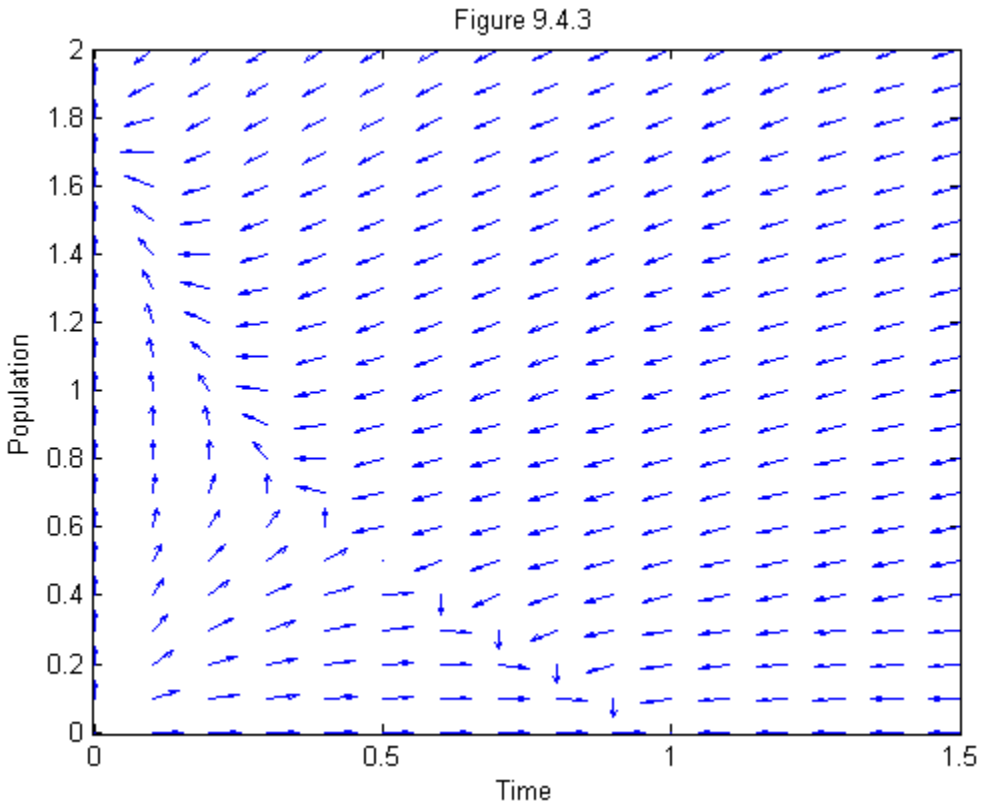
Tim Murray Extra Credit

Comparison between System 21 in Section 9.4 and System 2 in Section 9.5

Section 9.4 System (21) (GIVEN PROBLEM)

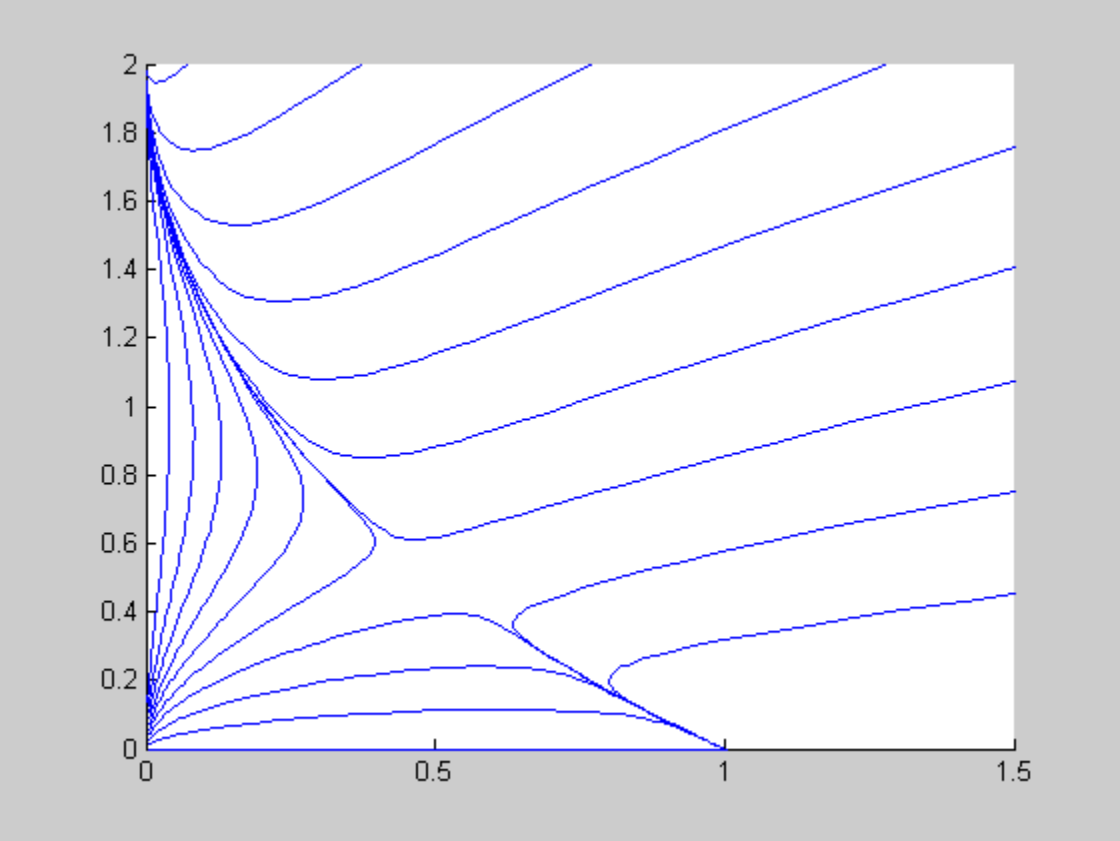
```
syms x y

[X, Y] = meshgrid(0:0.1:1.5, 0:0.1:2);

U = X-X.^2-X.*Y;

V = 0.5*Y-0.25*Y.^2-0.75*X.*Y;

L = sqrt((U).^2 + (V).^2);

quiver(X, Y, U./L, V./L, 0.4)

axis tight

xlabel Time

ylabel Population
```

```
title 'Figure 9.4.3'
```



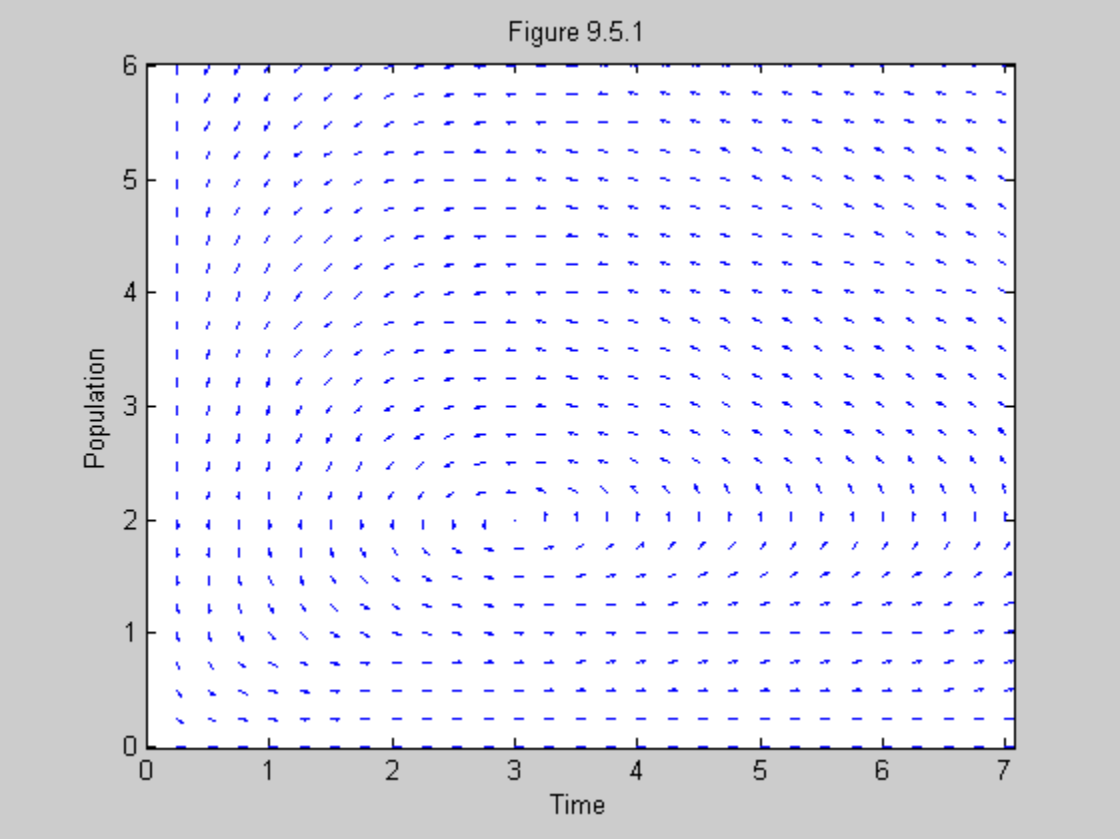
Section 9.4 System (21) Phase Portrait (GIVEN PROBLEM)

```
warning off all
f = @(t,x) [(x(1)*(1-x(1)-x(2)));...
    x(2)*(0.5-0.25*x(2)-0.75*x(1))];
figure; hold on
for a = -0.1:0.5:1
    for b = -2:0.1:2
        [t,xa] = ode45(f, [0 20], [a*b a*2.5*(1-b)]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a*b a*2.5*(1-b)]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 1.5 0 2])
```



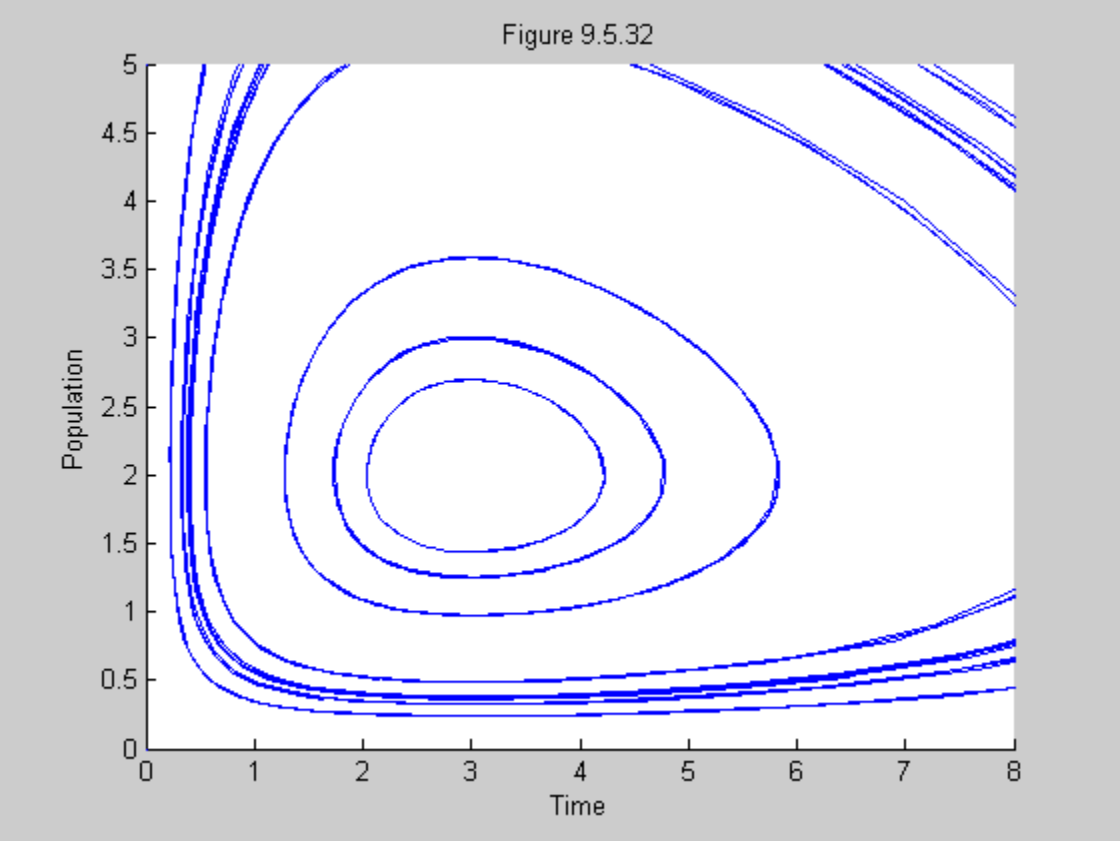
Section 9.5 System (2) Direction Field (GIVEN PROBLEM)

```
close all
clear all
syms x y
[X, Y] = meshgrid(0:0.25:7, 0:0.25:6);
U = X.*(1-0.5*Y);
V = Y.*(-0.75+0.25*X);
L = sqrt((U).^2 + (V).^2);
quiver(X, Y, U./L, V./L, 0.2)
axis tight
xlabel Time
ylabel Population
title 'Figure 9.5.1'
```



Section 9.5 System (2) Phase Protrait (GIVEN PROBLEM)

```
warning off all
f = @(t,x) [(x(1)*(1-0.5*x(2)));...
    x(2)*(-0.75+0.25*x(1))];
figure; hold on
for a = 0:1:4
    for b = 0:0.35:1
        [t,xa] = ode45(f, [0 20], [a*b a*2.5*(1-b)]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a*b a*2.5*(1-b)]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 8 0 5])
xlabel Time
ylabel Population
title 'Figure 9.5.32'
```



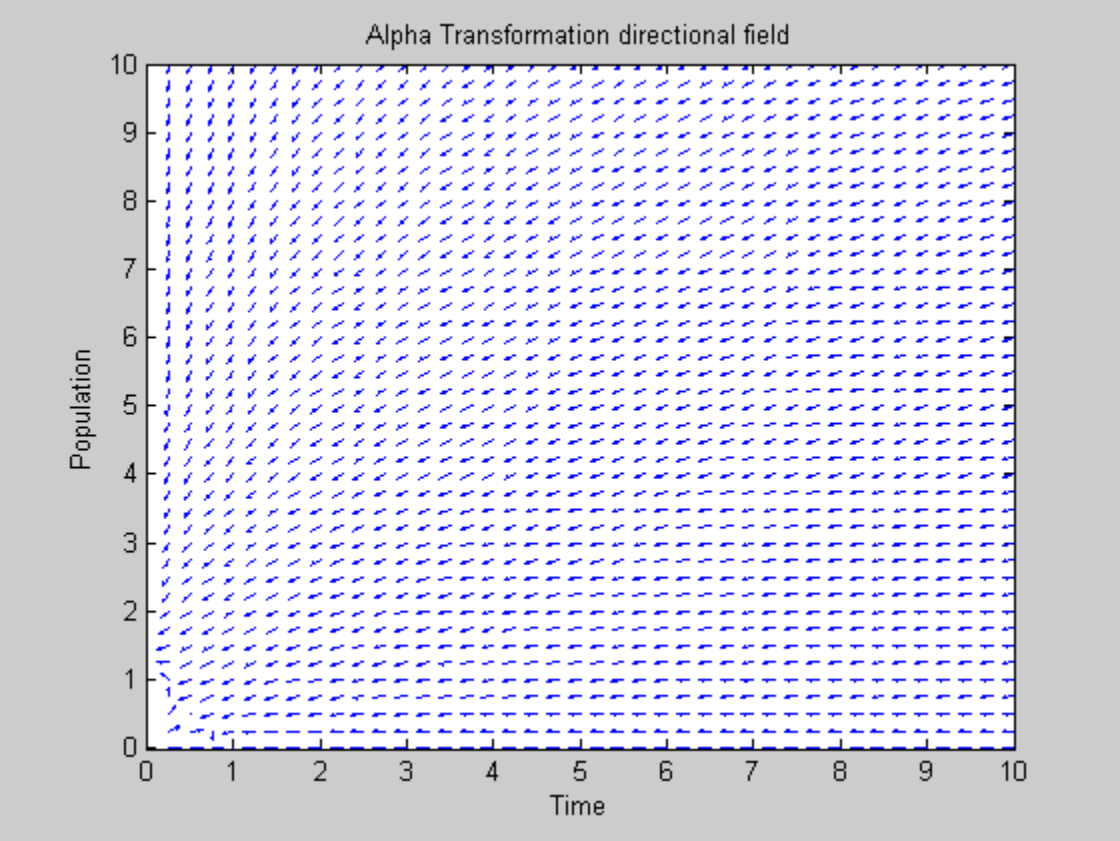
combining them together to get 1 phase portrait

Multiply U and V of each system by alpha to work at switching the coefficients of each system. Grouping the U and V equations from each system into one area

alpha = 0

```
clear all

close all

syms x y

[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);

alpha = 0;

U952 = X.*(1-0.5*Y);

V952 = Y.*(-0.75+0.25*X);

U9421 = X-X.^2-X.*Y;

V9421 = 0.5*Y-0.25*Y.^2-0.75*X.*Y;

% Creating the alpha portion
```

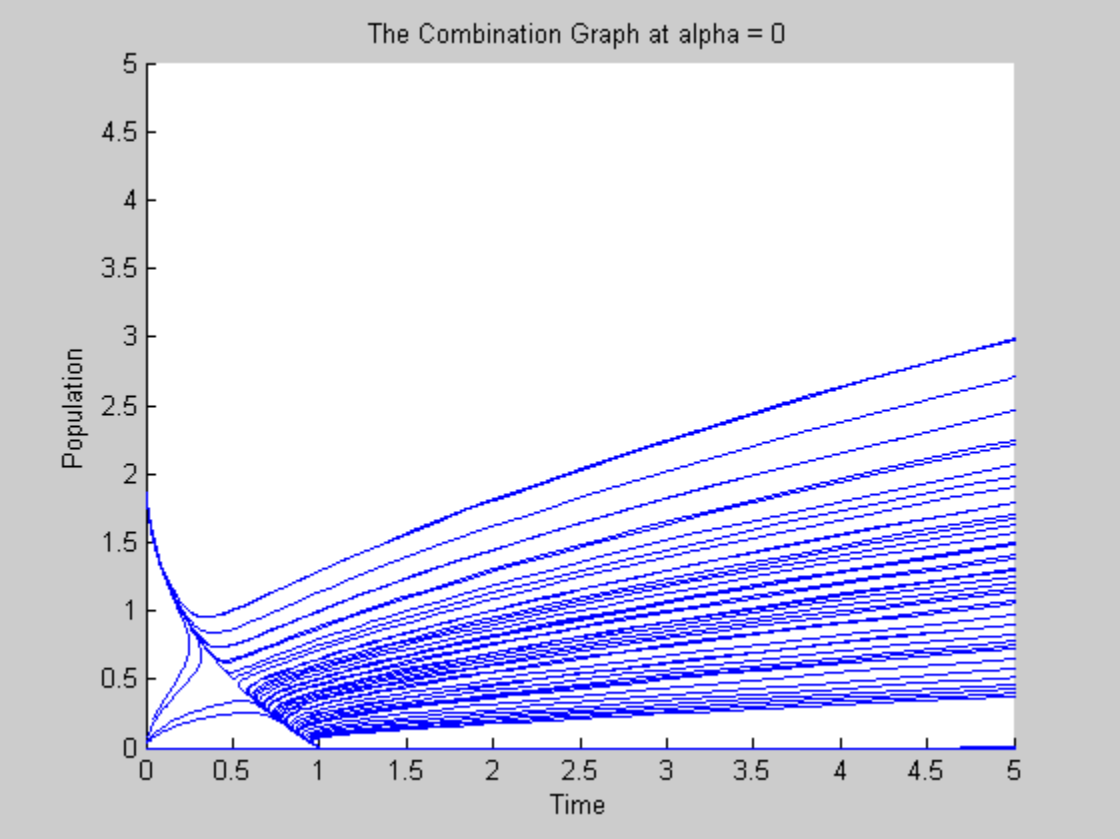
```
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0;
Unew = alpha*U952 - U9421*(alpha-1);
Vnew= alpha*V952 - V9421*(alpha-1);
Lnew = sqrt((Unew).^2 + (Vnew).^2);
quiver(X, Y, Unew./Lnew, Vnew./Lnew, 0.4)
axis tight
xlabel Time
ylabel Population
title 'Alpha Transformation directional field'
```



at alpha = 0

```
warning off all
f = @(t,x) [x(1)*(-x(1)-x(2)+1);...
    x(2)*(-0.75*x(1)-0.25*x(2)+0.5)];
figure; hold on
```

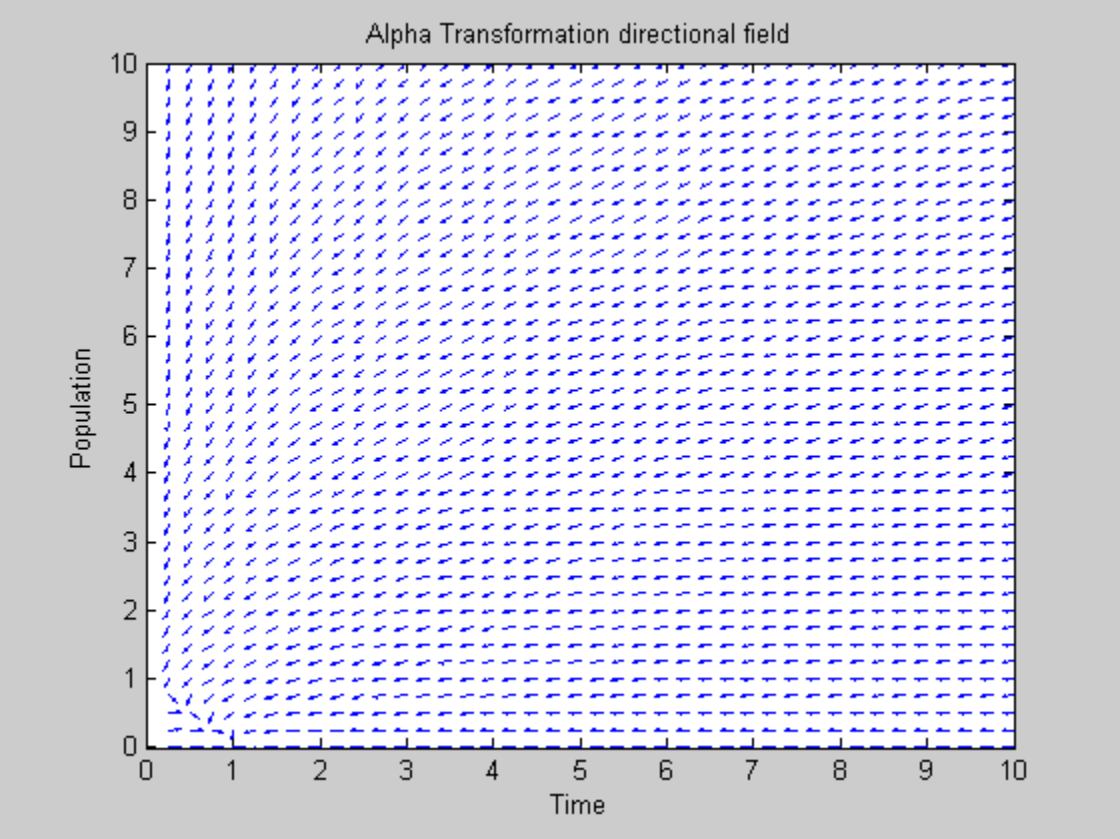
```
for a = 0:.25:3
    for b = 0:0.25:1
        [t,xa] = ode45(f, [0 20], [a b]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a b]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 5 0 5])
xlabel Time
ylabel Population
title 'The Combination Graph at alpha = 0'
```



Alpha = 0.2

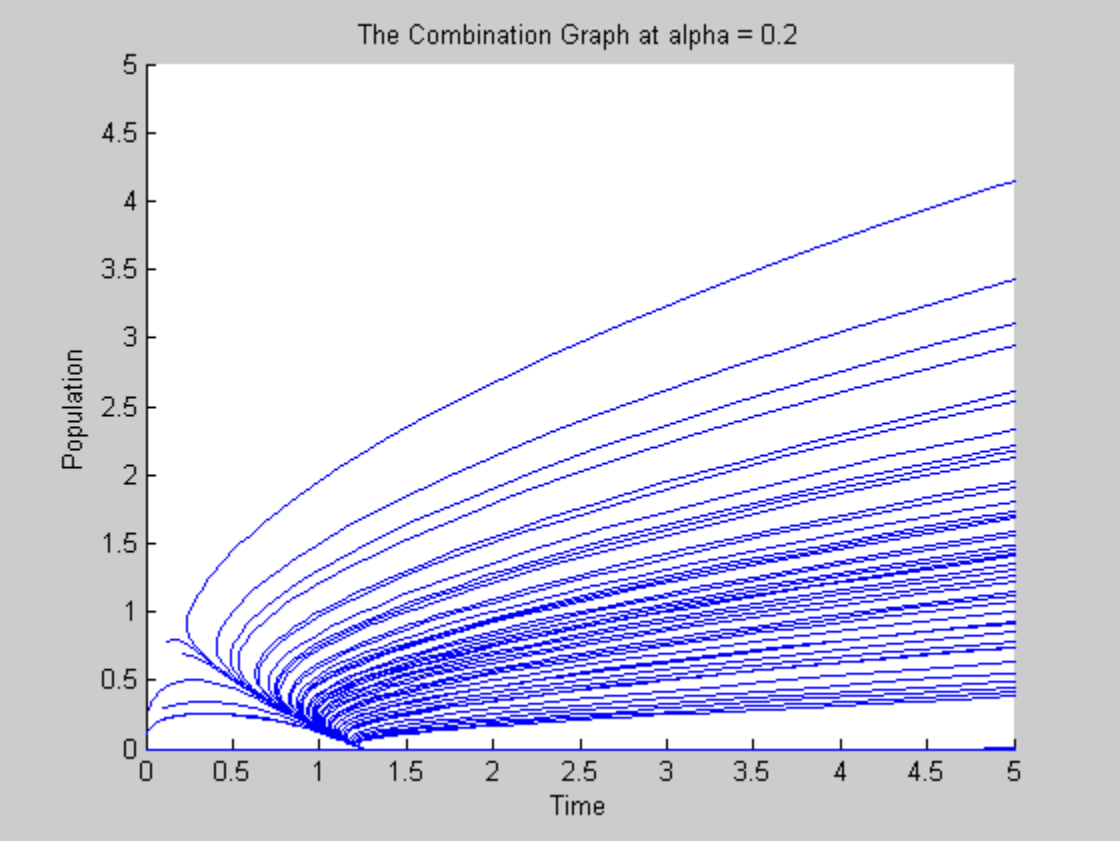
```
clear all
close all
syms x y
```

```
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.2;
U952 = X.*(1-0.5*Y);
V952 = Y.*(-0.75+0.25*X);
U9421 = X-X.^2-X.*Y;
V9421 = 0.5*Y-0.25*Y.^2-0.75*X.*Y;
% Creating the alpha portion
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.2;
Unew = alpha*U952 - U9421*(alpha-1);
Vnew= alpha*V952 - V9421*(alpha-1);
Lnew = sqrt((Unew).^2 + (Vnew).^2);
quiver(X, Y, Unew./Lnew, Vnew./Lnew, 0.4)
axis tight
xlabel Time
ylabel Population
title 'Alpha Transformation directional field'
```



at alpha = 0.2

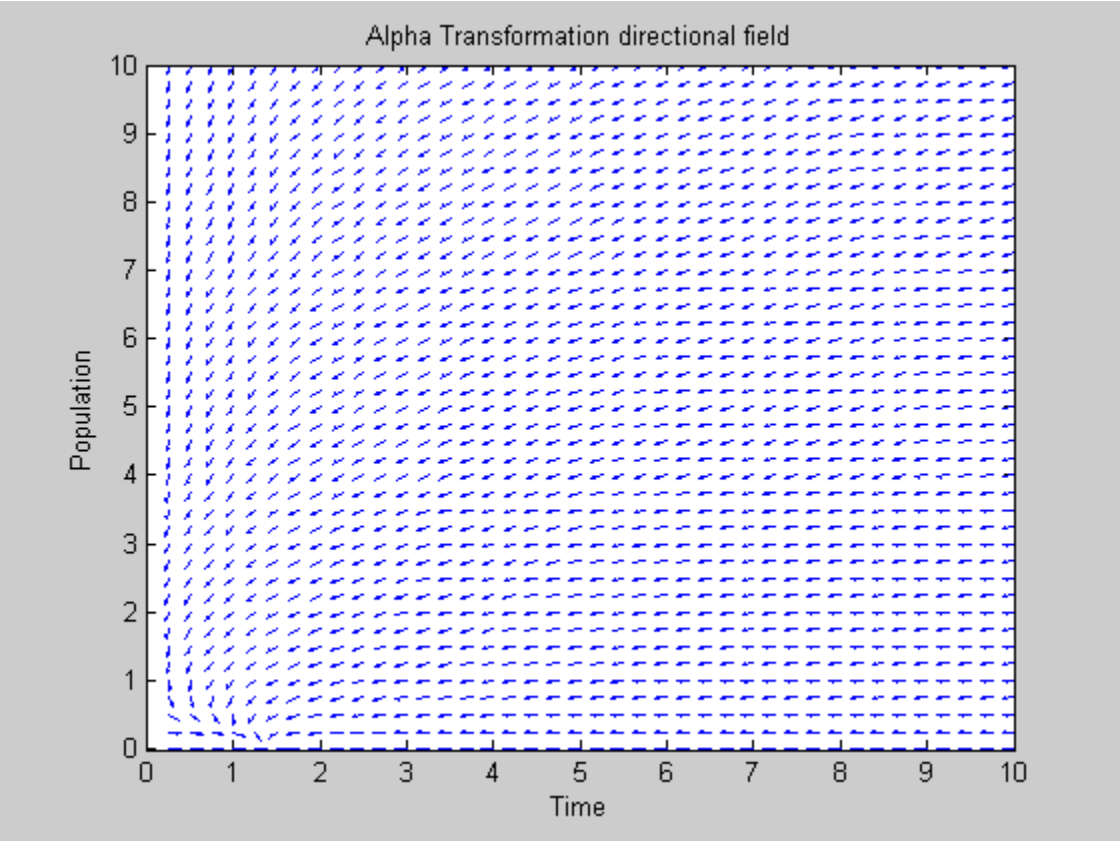
```
warning off all
f = @(t,x) [x(1)*(-0.8*x(1)-0.9*x(2)+1);...
    x(2)*(-0.55*x(1)-0.2*x(2)+0.25)];
figure; hold on
for a = 0:.25:3
    for b = 0:0.25:1
        [t,xa] = ode45(f, [0 20], [a b]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a b]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 5 0 5])
xlabel Time
ylabel Population
title 'The Combination Graph at alpha = 0.2'
```



alpha = 0.4

```
clear all
close all
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.4;
U952 = X.*(1-0.5*Y);
V952 = Y.*(-0.75+0.25*X);
U9421 = X-X.^2-X.*Y;
V9421 = 0.5*Y-0.25*Y.^2-0.75*X.*Y;
% Creating the alpha portion
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.4;
Unew = alpha*U952 - U9421*(alpha-1);
Vnew= alpha*V952 - V9421*(alpha-1);
```

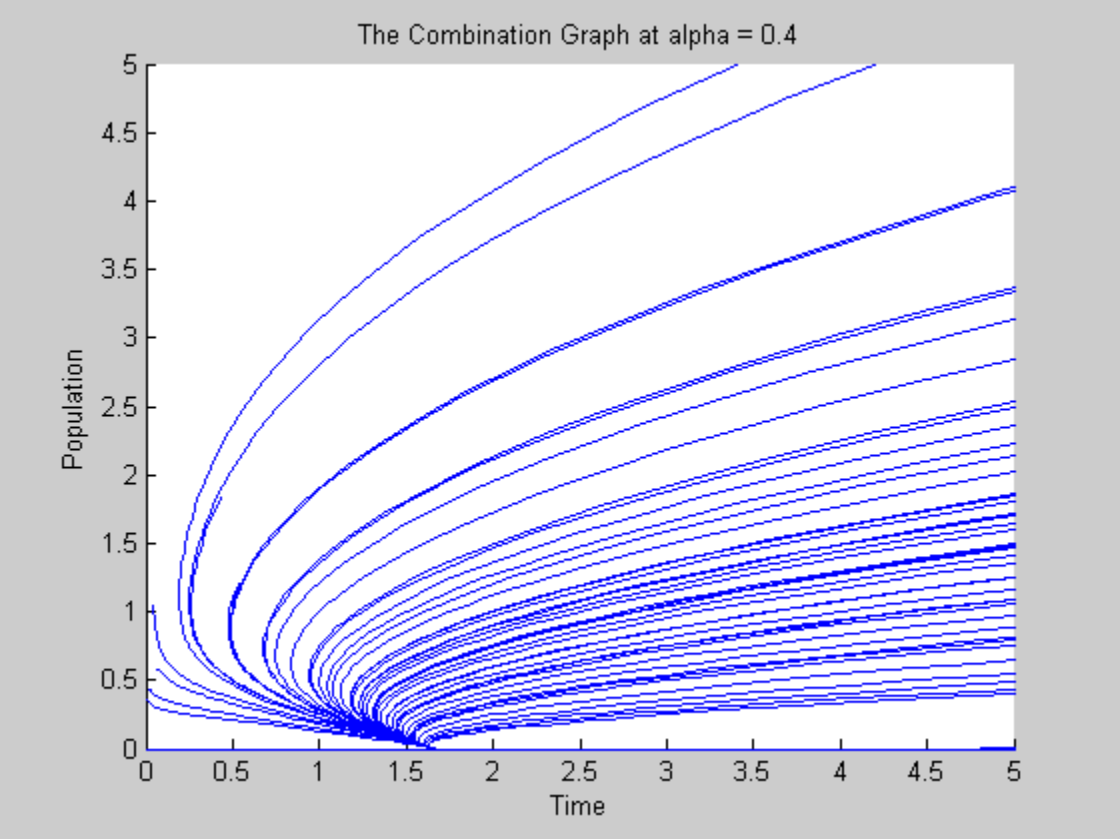
```
Lnew = sqrt((Unew).^2 + (Vnew).^2);
quiver(X, Y, Unew./Lnew, Vnew./Lnew, 0.4)
axis tight
xlabel Time
ylabel Population
title 'Alpha Transformation directional field'
```



at alpha = 0.4

```
warning off all
f = @(t,x) [x(1)*(-0.6*x(1)-0.8*x(2)+1);...
    x(2)*(-0.35*x(1)-0.15*x(2))];
figure; hold on
for a = 0:.25:3
    for b = 0:0.25:1
        [t,xa] = ode45(f, [0 20], [a b]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a b]);
```

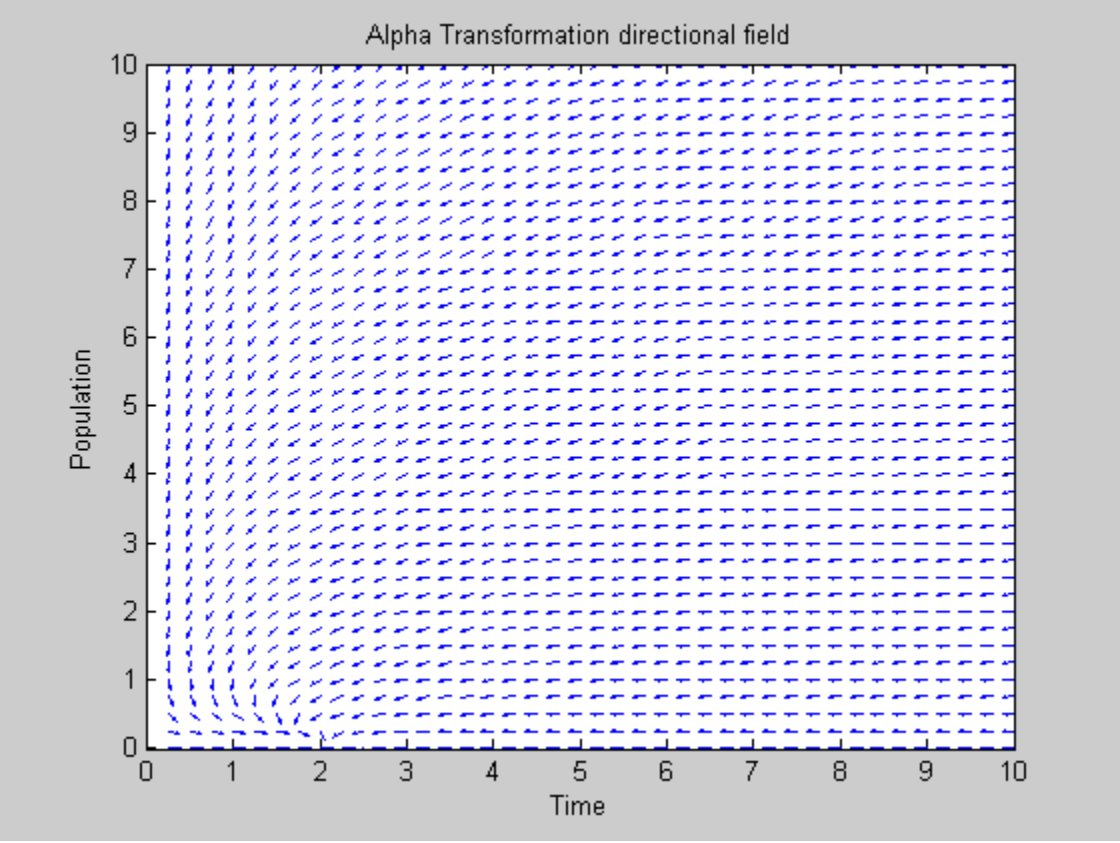
```
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 5 0 5])
xlabel Time
ylabel Population
title 'The Combination Graph at alpha = 0.4'
% When alpha = 0.4, the populations die down to a constant rate.
```



alpha = 0.6

```
clear all
close all
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.6;
U952 = X.*(1-0.5*Y);
V952 = Y.*(-0.75+0.25*X);
```

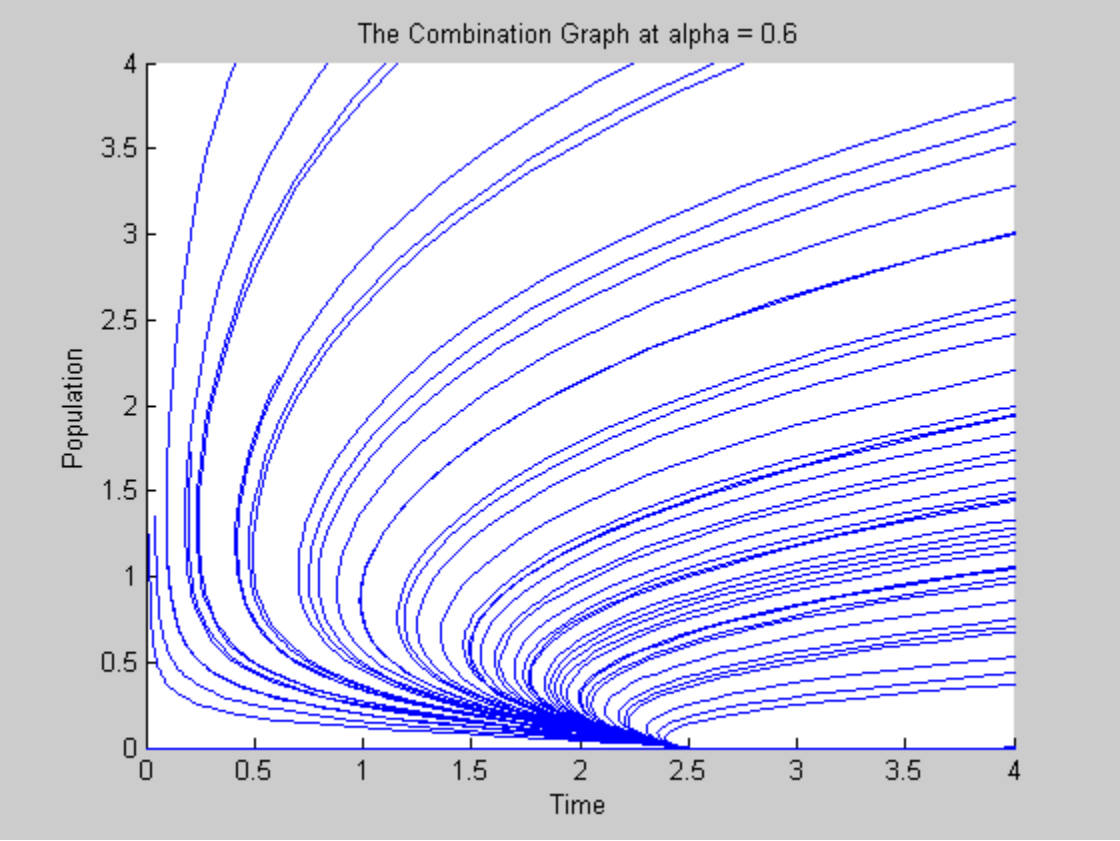
```
U9421 = X-X.^2-X.*Y;
V9421 = 0.5*Y-0.25*Y.^2-0.75*X.*Y;
% Creating the alpha portion
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.6;
Unew = alpha*U952 - U9421*(alpha-1);
Vnew= alpha*V952 - V9421*(alpha-1);
Lnew = sqrt((Unew).^2 + (Vnew).^2);
quiver(X, Y, Unew./Lnew, Vnew./Lnew, 0.4)
axis tight
xlabel Time
ylabel Population
title 'Alpha Transformation directional field'
```



at alpha = 0.6

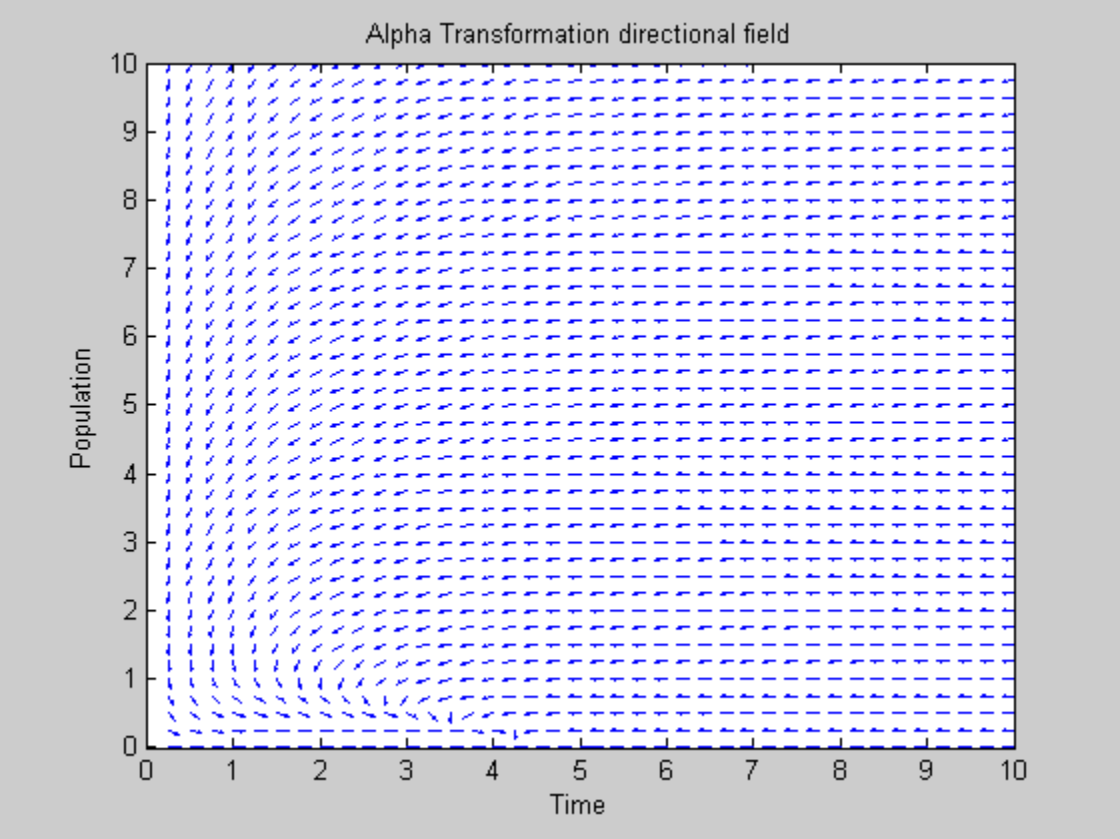
```
warning off all
```

```
f = @(t,x) [x(1)*(-0.4*x(1)-0.7*x(2)+1);...
    x(2)*(-0.15*x(1)-0.1*x(2)-0.25)];
figure; hold on
for a = 0:.25:3
    for b = 0:0.25:1
        [t,xa] = ode45(f, [0 20], [a b]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a b]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 4 0 4])
xlabel Time
ylabel Population
title 'The Combination Graph at alpha = 0.6'
% When alpha is equal to 0.6, the population dies down to a constant rate.
```



alpha = 0.8

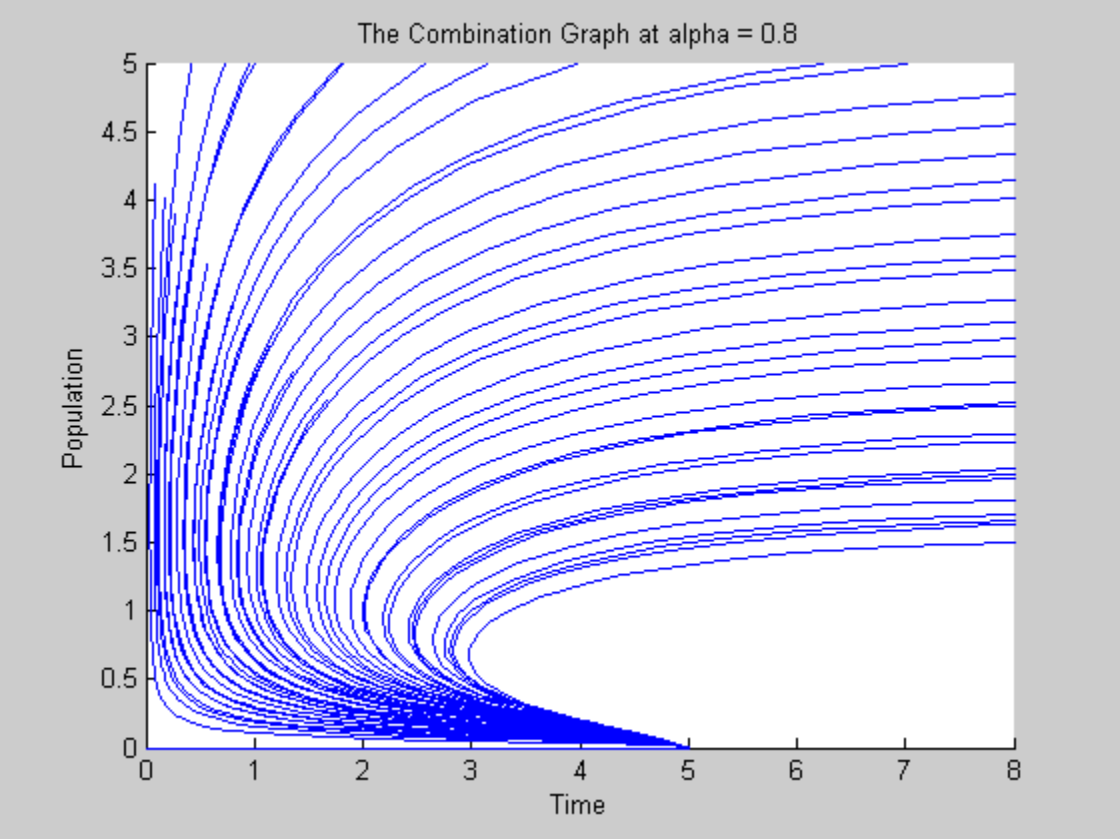
```
clear all

close all

syms x y

[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);

alpha = 0.8;

U952 = X.*(1-0.5*Y);

V952 = Y.*(-0.75+0.25*X);

U9421 = X-X.^2-X.*Y;

V9421 = 0.5*Y-0.25*Y.^2-0.75*X.*Y;

% Creating the alpha portion

syms x y

[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);

alpha = 0.8;

Unew = alpha*U952 - U9421*(alpha-1);

Vnew= alpha*V952 - V9421*(alpha-1);

Lnew = sqrt((Unew).^2 + (Vnew).^2);

quiver(X, Y, Unew./Lnew, Vnew./Lnew, 0.4)

axis tight

xlabel Time

ylabel Population

title 'Alpha Transformation directional field'
```



at alpha = 0.8

```
warning off all
f = @(t,x) [x(1)*(-0.2*x(1)-0.6*x(2)+1);...
    x(2)*(0.05*x(1)-0.05*x(2)-0.5)];
figure; hold on
for a = 0:.25:3
    for b = 0:0.25:1
        [t,xa] = ode45(f, [0 20], [a b]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a b]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 8 0 5])
xlabel Time
ylabel Population
title 'The Combination Graph at alpha = 0.8'
```

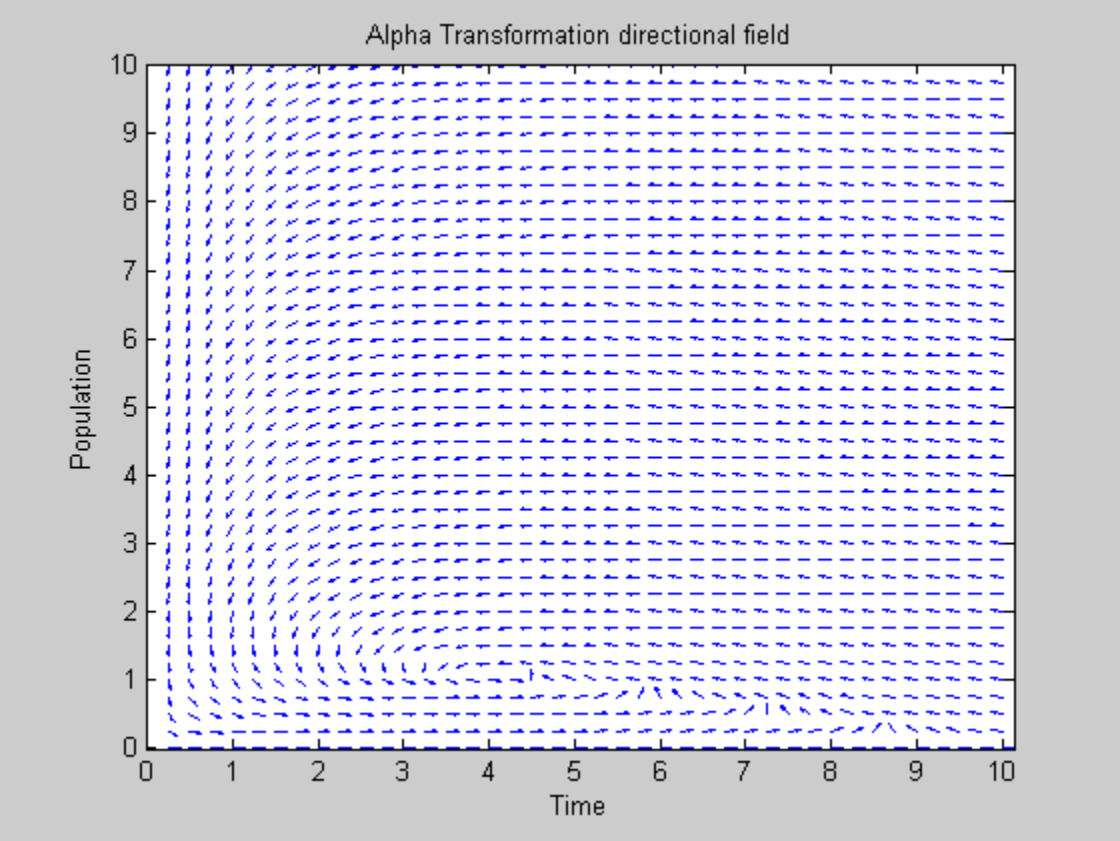
```
% For when alpha is equal to 0.8, the population dies down.
```



alpha = 0.9

```
clear all
close all
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.9;
U952 = X.*(1-0.5*Y);
V952 = Y.*(-0.75+0.25*X);
U9421 = X-X.^2-X.*Y;
V9421 = 0.5*Y-0.25*Y.^2-0.75*X.*Y;
% Creating the alpha portion
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 0.9;
Unew = alpha*U952 - U9421*(alpha-1);
```

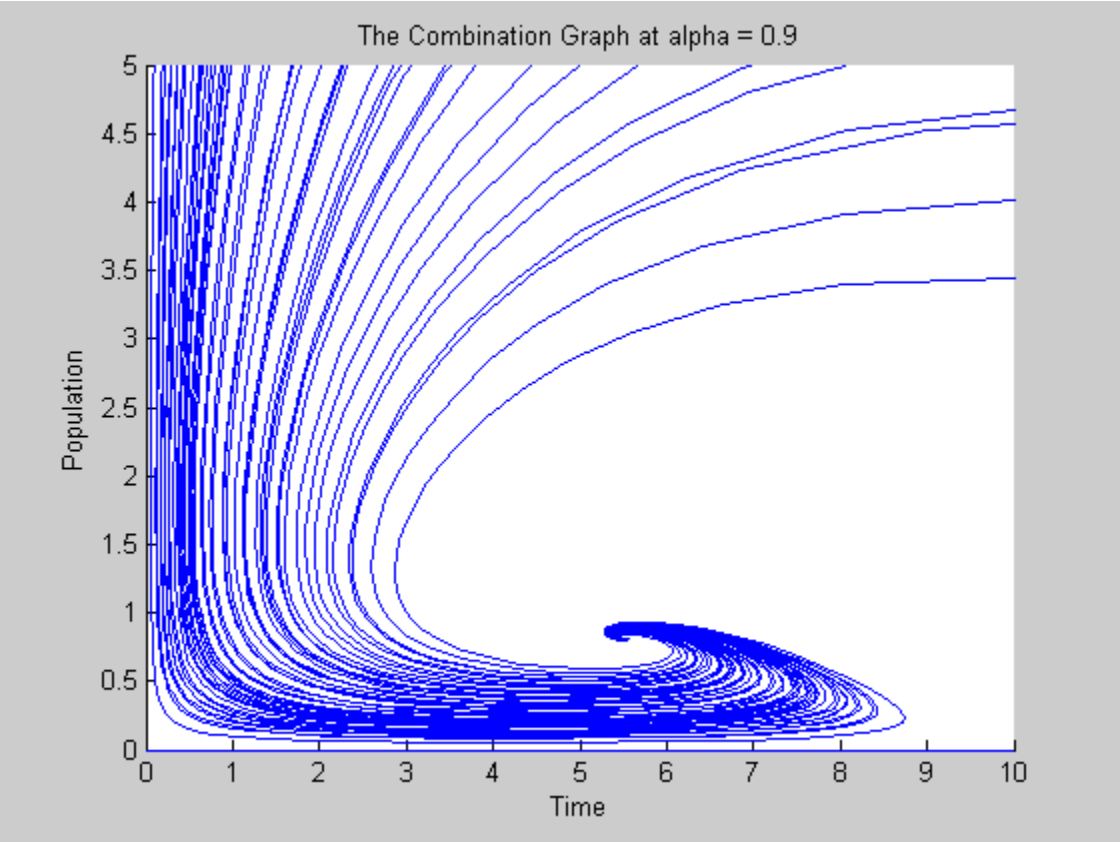
```
Vnew= alpha*V952 - V9421*(alpha-1);
Lnew = sqrt((Unew).^2 + (Vnew).^2);
quiver(X, Y, Unew./Lnew, Vnew./Lnew, 0.4)
axis tight
xlabel Time
ylabel Population
title 'Alpha Transformation directional field'
```



at alpha = 0.9

```
warning off all
f = @(t,x) [x(1)*(-0.1*x(1)-0.55*x(2)+1);...
    x(2)*(0.15*x(1)-0.25*x(2)-0.625)];
figure; hold on
for a = 0:.25:3
    for b = 0:0.25:1
        [t,xa] = ode45(f, [0 20], [a b]);
        plot(xa(:,1),xa(:,2))
```

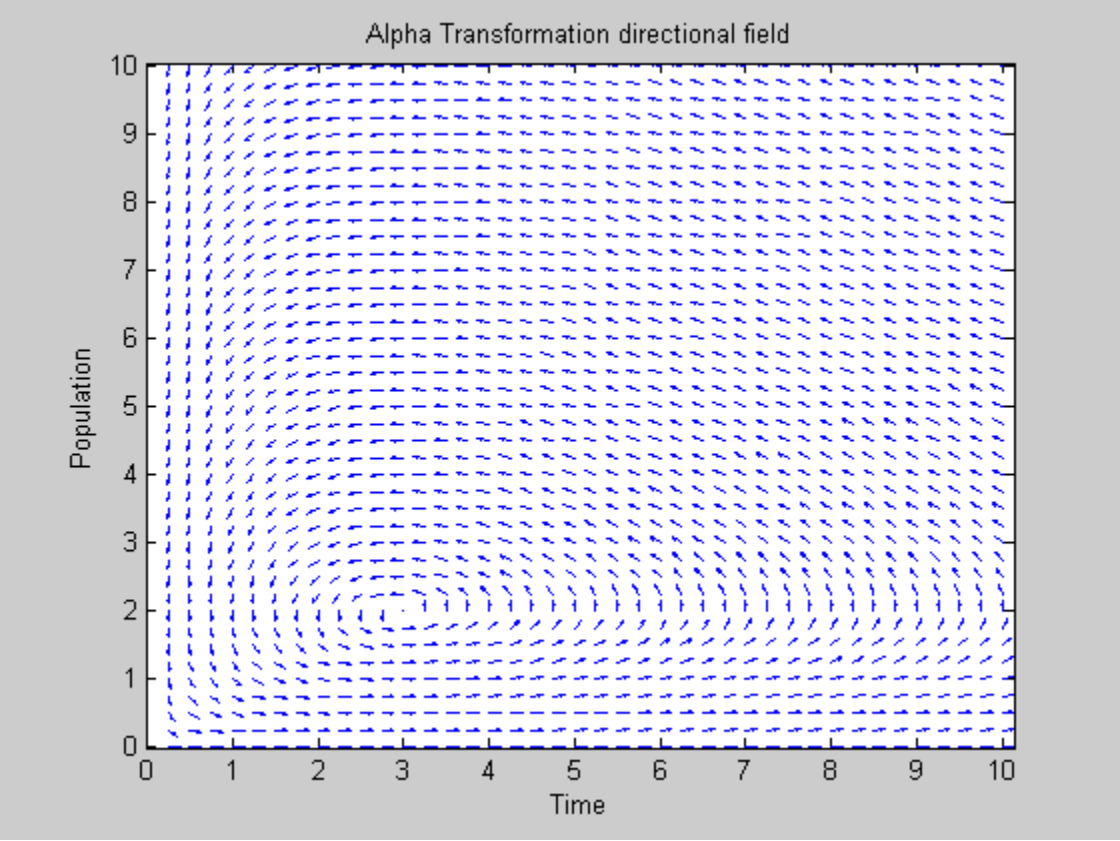
```
        [t,xa] = ode45(f, [0  -5], [a b]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 10 0 5])
xlabel Time
ylabel Population
title 'The Combination Graph at alpha = 0.9'
% Here, the population of the species will spiral down into a centralized
% point.
```



alpha = 1

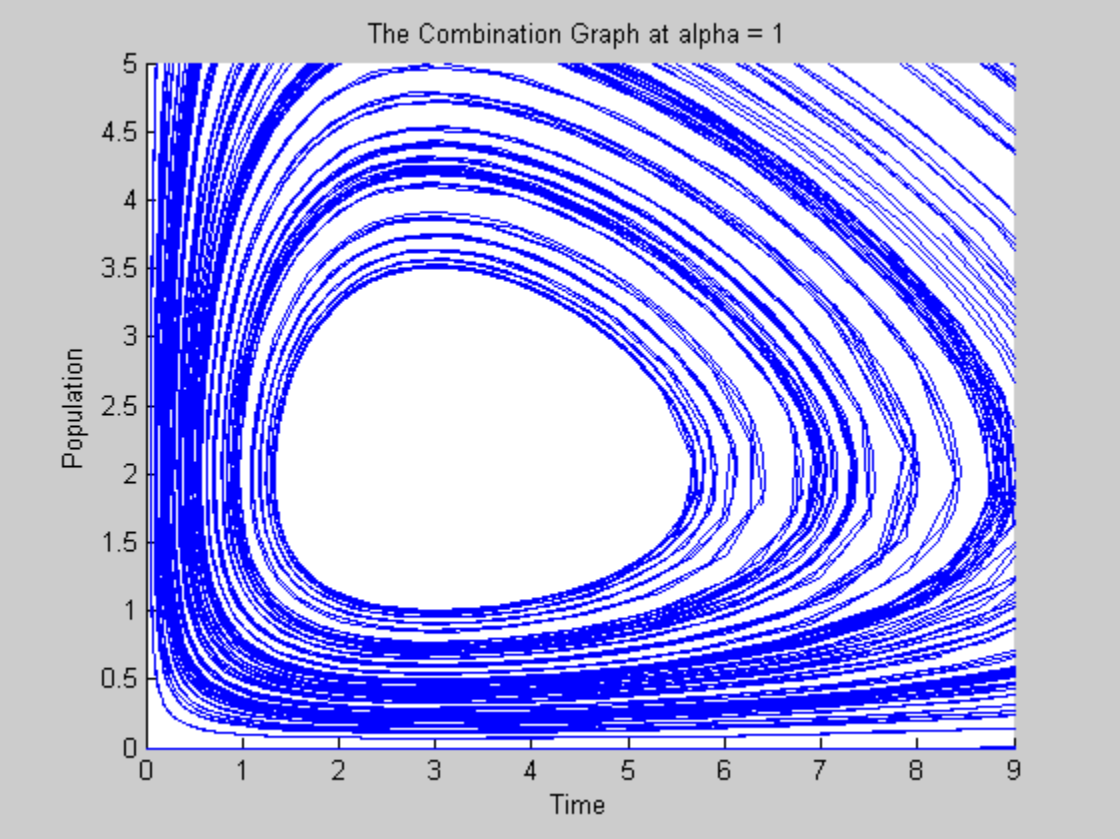
```
clear all
close all
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 1;
```

```
U952 = X.*(1-0.5*Y);
V952 = Y.*(-0.75+0.25*X);
U9421 = X-X.^2-X.*Y;
V9421 = 0.5*Y-0.25*Y.^2-0.75*X.*Y;
% Creating the alpha portion
syms x y
[X, Y] = meshgrid(0:0.25:10, 0:0.25:10);
alpha = 1;
Unew = alpha*U952 - U9421*(alpha-1);
Vnew= alpha*V952 - V9421*(alpha-1);
Lnew = sqrt((Unew).^2 + (Vnew).^2);
quiver(X, Y, Unew./Lnew, Vnew./Lnew, 0.4)
axis tight
xlabel Time
ylabel Population
title 'Alpha Transformation directional field'
```



at alpha = 1

```
warning off all
f = @(t,x) [x(1)*(1-0.5*x(2));...
    x(2)*(0.25*x(1)-0.75)];
figure; hold on
for a = 0:.25:3
    for b = 0:0.25:1
        [t,xa] = ode45(f, [0 20], [a b]);
        plot(xa(:,1),xa(:,2))
        [t,xa] = ode45(f, [0  -5], [a b]);
        plot(xa(:,1),xa(:,2))
    end
end
axis([0 9 0 5])
xlabel Time
ylabel Population
title 'The Combination Graph at alpha = 1'
% This graph represents the population as one species interacts with
% another.  The two species will trade places between population, but it
% will be an ever-changing, always rotating cycle.  Going from virtually no
% interation at alpha = 0 to an interaction that depends on one another for
% survival can be seen throughout this transformation process.
```


The Combination Graph at alpha = 1
Population
Time
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
1
2
3
4
5
6
7
8
9