Bowei Zhu
MATH246
Extra Credit question:

$$\frac{d}{dt}\begin{pmatrix}x\\y\end{pmatrix} = (1-\alpha)\begin{pmatrix}x(1.5-x-0.5y)\\y(2-0.5y-1.5x)\end{pmatrix} + \alpha\begin{pmatrix}x(1.125-x-0.5y)\\y(-1+x)\end{pmatrix}$$

```
>> [X,Y] = meshgrid(0:.1:2.5, 0:.1:2.5);
U1=X.*(1.5-X-0.5*Y);
V1=Y.*(2-0.5*Y-1.5*X);
U2=X.*(1.125-X-.5*Y);
V2=Y.*(-1+X);
warning off all
for alpha=0:.1:1
figure;hold on
U=(1-alpha)*U1+alpha*U2;
V=(1-alpha)*V1+alpha*V2;
L=sqrt(U.^2+V.^2);
quiver(X,Y, U./L,V./L,.5)
axis equal
f=@(t,x)[(1-alpha)*x(1)*(1.5-x(1)-0.5*x(2))+alpha*x(1)*(1.125-x(1)-0.5*x(2));(1-alp
ha)*x(2)*(2-0.5*x(2)-1.5*x(1))+alpha*x(2)*(x(2)*(x(1)-1))];
for a=-2:.25:2
for b=-2:.25:2
[t,xa]=ode45(f,[0 10],[a b],'r');
plot(xa(:,1),xa(:,2));
[t,xa]=ode45(f,[0 -5],[a b],'r');
plot(xa(:,1),xa(:,2));
end
end
axis([0 2.5 0 2.5])
title(alpha)
end
```

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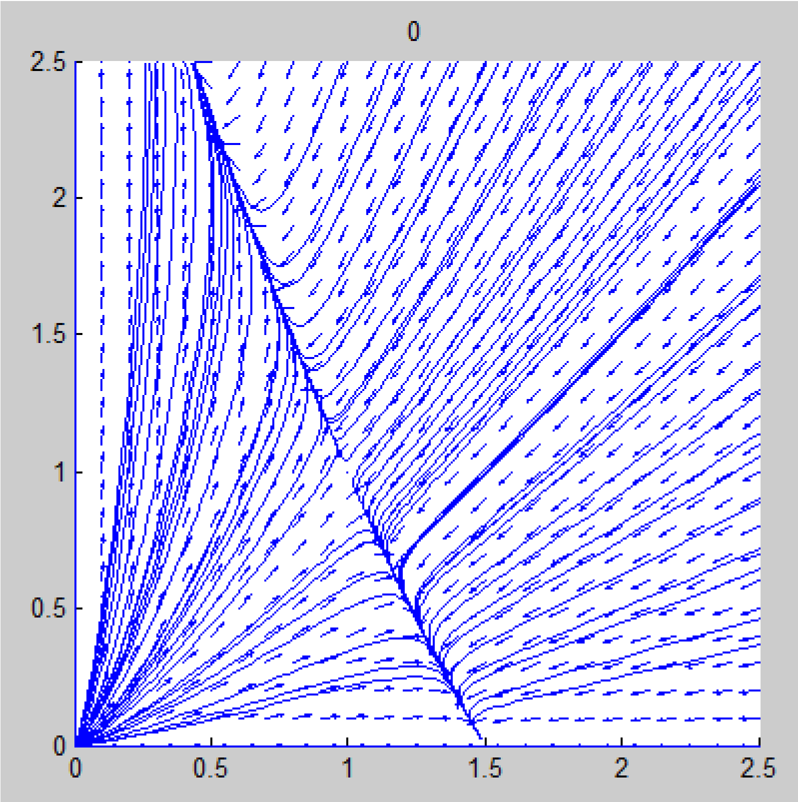

At α=0 the model is purely competing species. There are critical points at (0,0) and (1,1). This model reflects at a time where there are two species that are competing for the same supply of food. All initial values tend towards a line that runs from (1.5,0) to (0,4). There are no signs or traits of predator-prey model. Thus implying that none of these species are able to kill and consuming the other for food.

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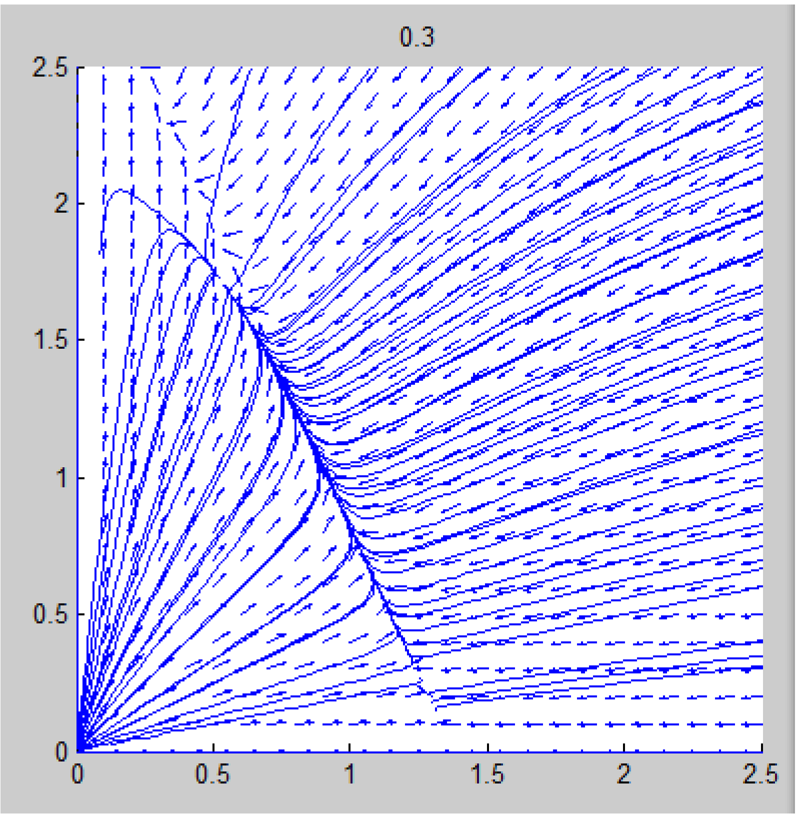

At this point α=0.3 and the predator-prey model is beginning to take over the competing species model. The critical points at (1,1) has shifted to approximately (1.3, 0.3). This is a sign that some species have evolved into eating its competitor but it is not fully evolved. The top of the curve is starting to curl, changing into a predator prey model.

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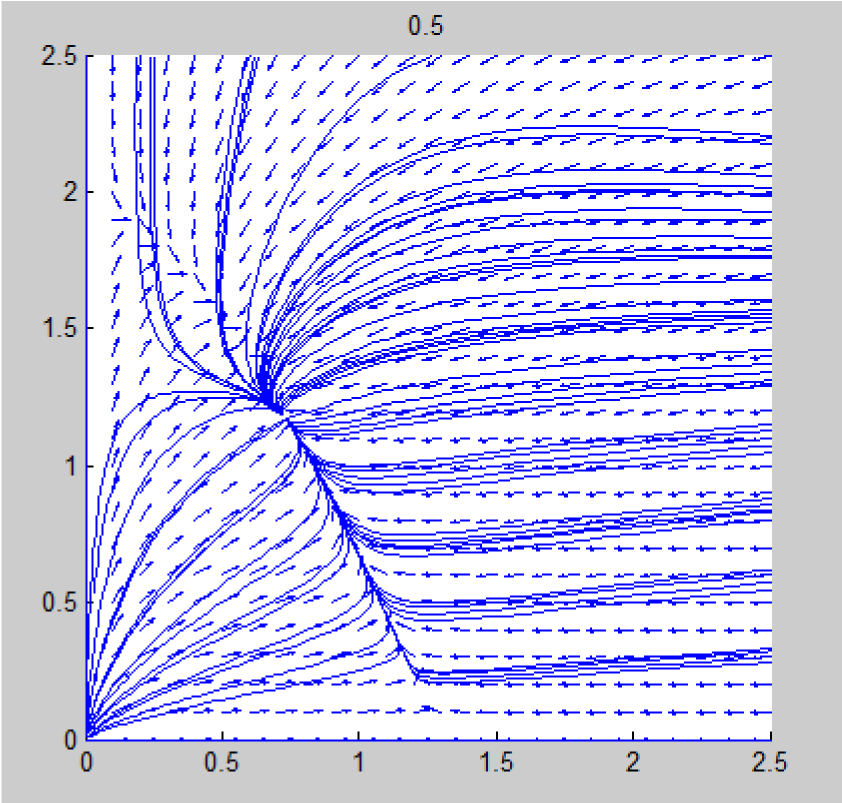

At α=.5 the model is evenly split between competing species and predator-prey. However since the formula in the predator prey has an “x” squared, the predator-prey image isn’t complete. Its evolving to that shape, as there is a clear line at the approximately from (1.3, 0) to (0.8, 1.2). The top however is like a whirlpool cycling inwards to the point of (0.8, 1.2), which is the critical point in this case. This shows that there is a big mess, a mixture between both completing species and predator and prey. This phase portrait is beginning to get dominated by the predator prey model as there is a significant inward curl.

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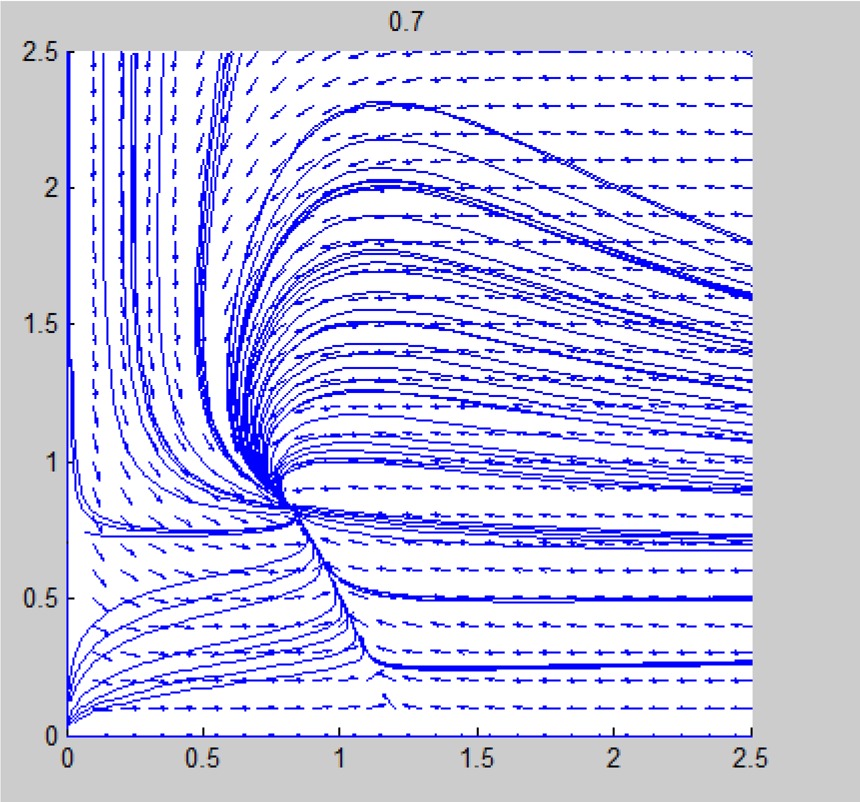

At α= .7 the predator-prey model has almost completely overwhelmed the competing species model. The critical point seemed more stable as all points towards approximately the point (0.8, 0.8). This shows that there will be an equilibrium as the predator prey model continues to dominate over the competing species. Despite the fact that the predator prey is dominating, there are still signs of the competing species model.

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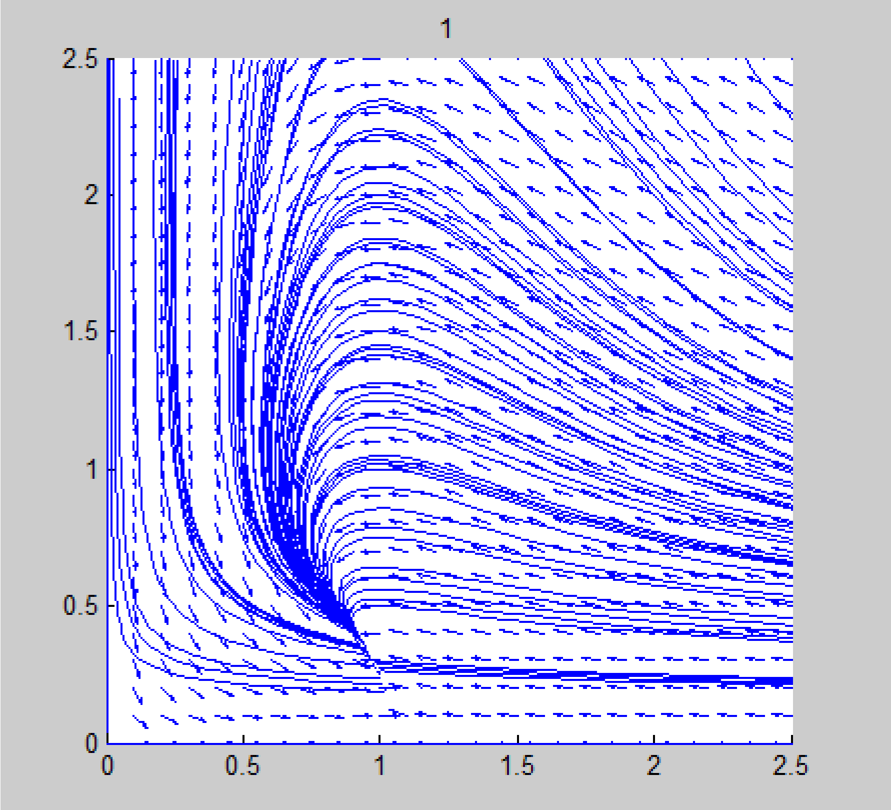

At α= 1 the predator-prey model has completely overwhelmed the competing species model. The critical point seemed more stable as all points towards approximately the point (0.9,0.25). The predator prey model has completely dominated the competing species. Therefore there are no signs of competing species model anywhere to be seen. Since the formula had and "x" squared, the model is not a pure predator-prey model. However it still represents the predator prey concept pretty clearly. Unlike what the usual predator prey model conveys, this model states that there will be an equilibrium to where amount of spices there are left. There will always be a certain number of predator and prey.