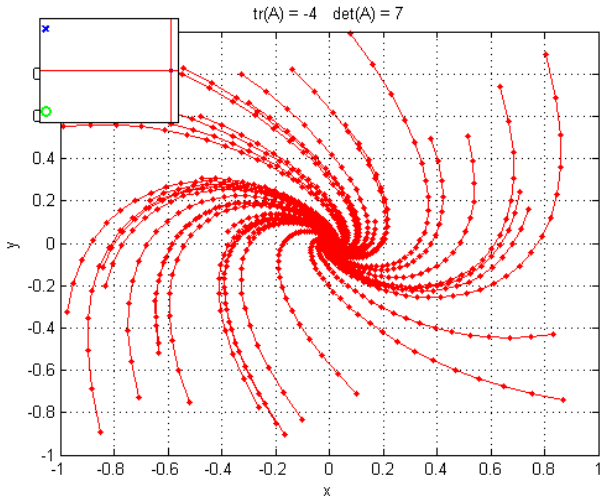
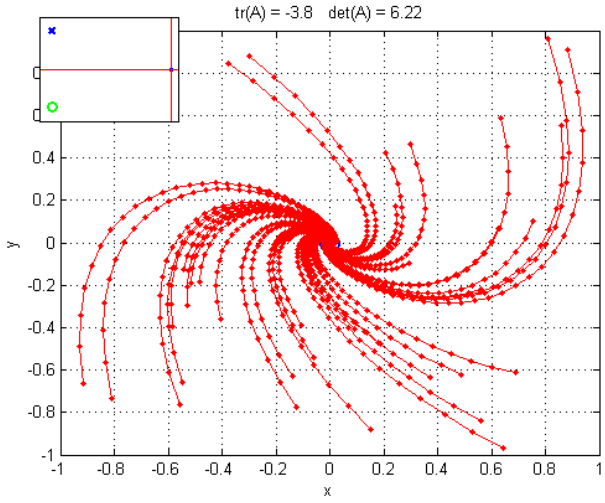
```
%Phase plane as u goes from -2 to 2
for u=-2:.1:2
    A=[u+1, -u; u ,u-1];
    pplane(A)
    hold on
end
```

```
function pplane(A)

% pplane.m Plots the eigenvectors, eigenvalues, and representative
%          phase portraits for
%
%          d[x; y]/dt = A[x; y]
%
%          for -1<x<1, -1<y<1. Called as
%
%          pplane(A)
%
%          where A is the 2x2 coefficient array. Calls lodesolver.m,
%          so be sure that function is in the current path

[U,S] = eig(A);

lam = diag(S);

if lam(1) == lam(2)
    % manually set u2 to be orthogonal to u1
    U(:,2) = [-U(2,1); U(1,1)];
end

figure

if isreal(lam(1))

    plot([-U(1,1) U(1,1)],[-U(2,1) U(2,1)],'--', ...
        [-U(1,2) U(1,2)],[-U(2,2) U(2,2)],'Linewidth',2)
    legend('u_1','u_2')
else
    plot(0,0,'o','MarkerSize',12,'LineWidth',2)
end
xlabel('x'), ylabel('y')
grid on
trA = A(1,1)+A(2,2);
detA = A(1,1)*A(2,2) - A(1,2)*A(2,1);
title(['tr(A) = ',num2str(trA),'   det(A) = ',num2str(detA)])

tmax = sqrt(abs(lam(1))^2+abs(lam(2))^2)/2;
incr = 1/max(abs(lam))/20;
t = [0:0.05:tmax];
hold on
for i = 1:40
    z0 = 2*rand(2,1)-[1;1];
    z = lodesolver(A,t,z0);
```

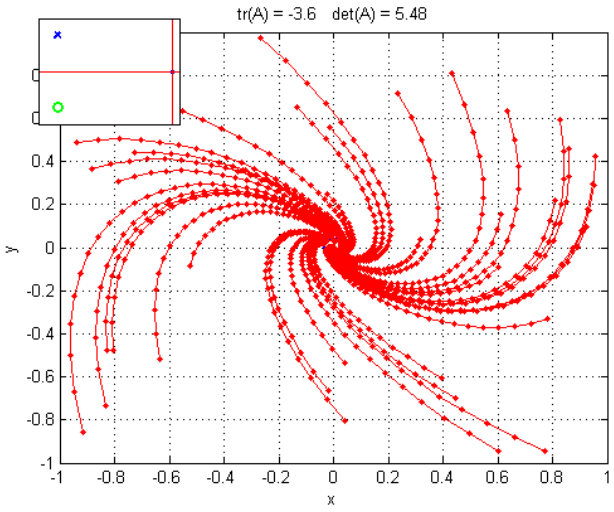
```
    plot(z(1,:),z(2,:),'r.-')
end
hold off

H = axes('position',[0.1 0.75 0.2 0.2]);
plot(real(lam(1)),imag(lam(1)),'bX',real(lam(2)),imag(lam(2)),'go', ...
    0,0,'.','LineWidth',2)
ax = axis;
xrng = ax(2)-ax(1); yrng = ax(4)-ax(3);
hold on
plot([ax(1)-0.05*xrng ax(2)+0.05*xrng],[0 0],'r', ...
    [0 0],[ax(3)-0.05*yrng ax(4)+0.05*yrng],'r')
axis tight
hold off

set(H,'YTick',[]),set(H,'XTick',[])

drawnow
```



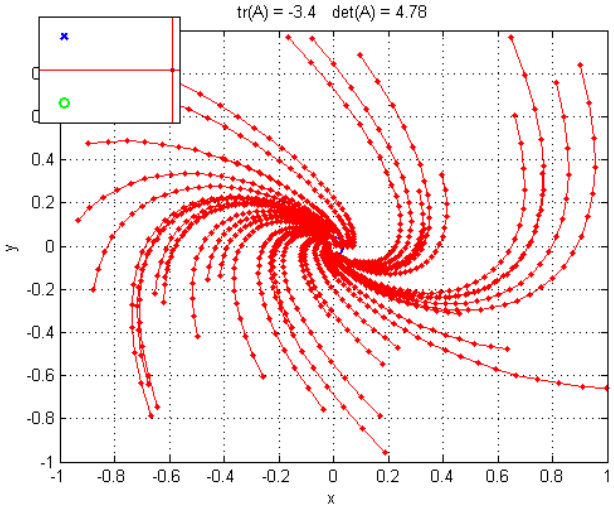
for u=-2



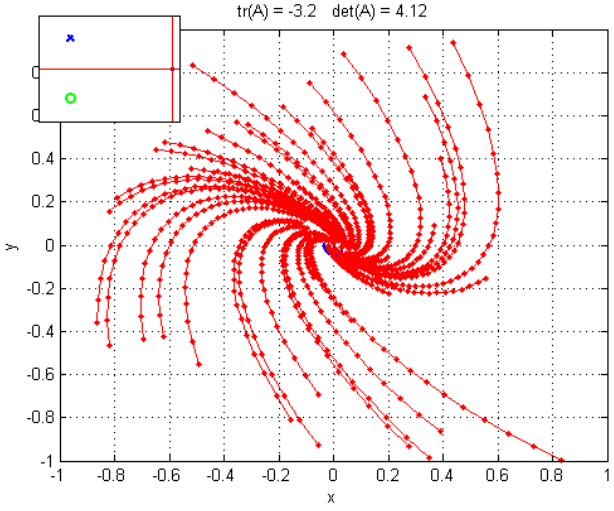
for u=-1.9



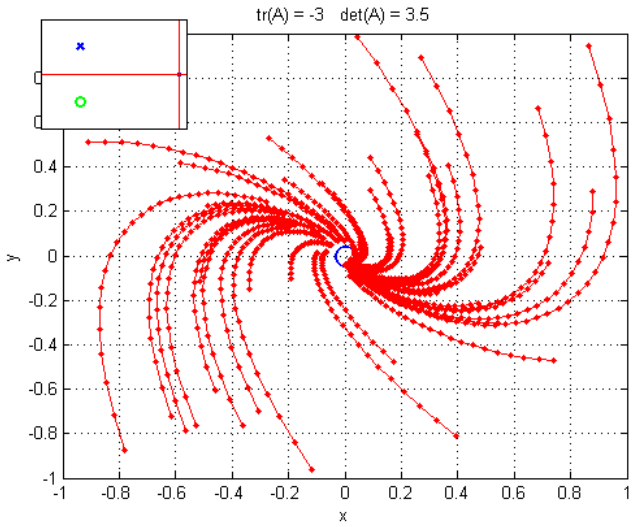
for u=-1.8



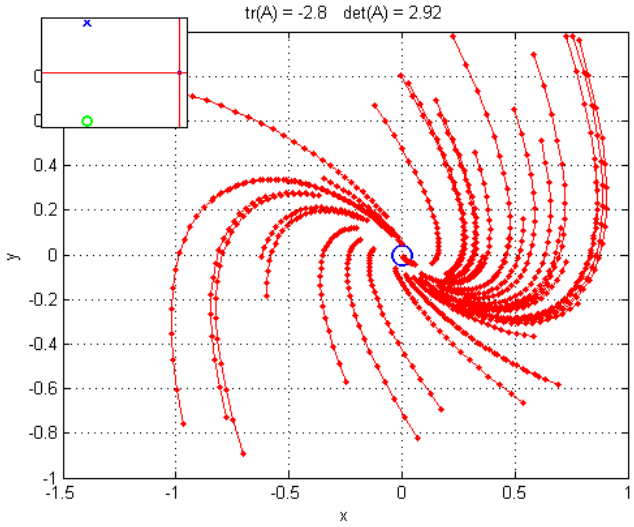
for u=-1.7



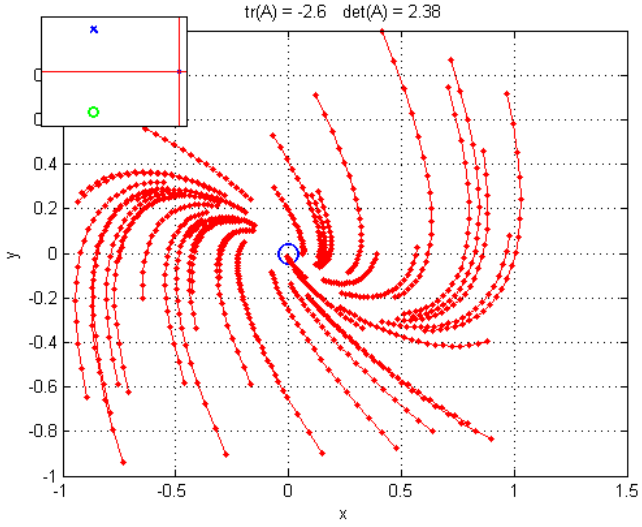
for u=-1.6



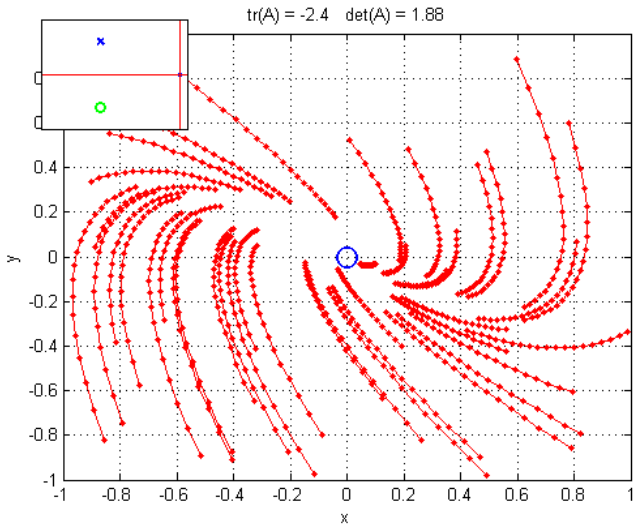
for u=-1.5



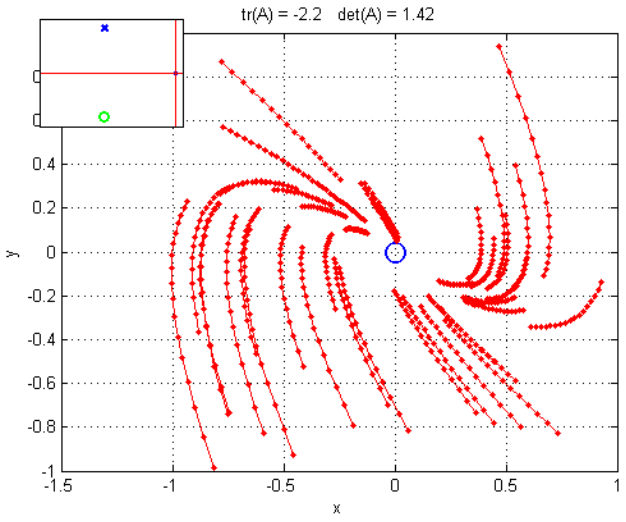
for u=-1.4



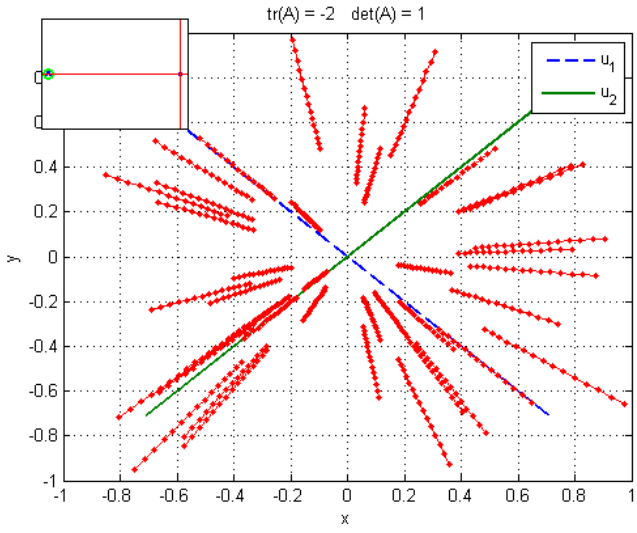
for u=-1.3



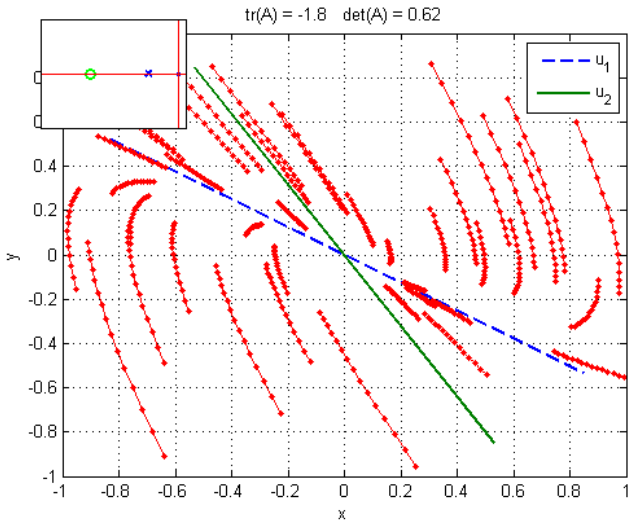
for u=-1.2



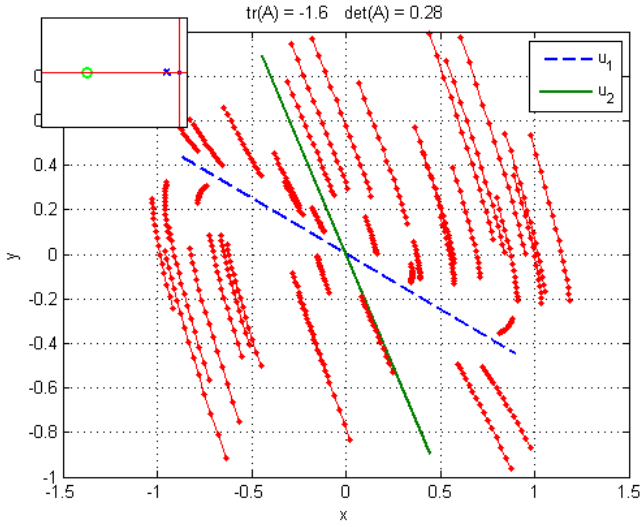
for u=-1.1



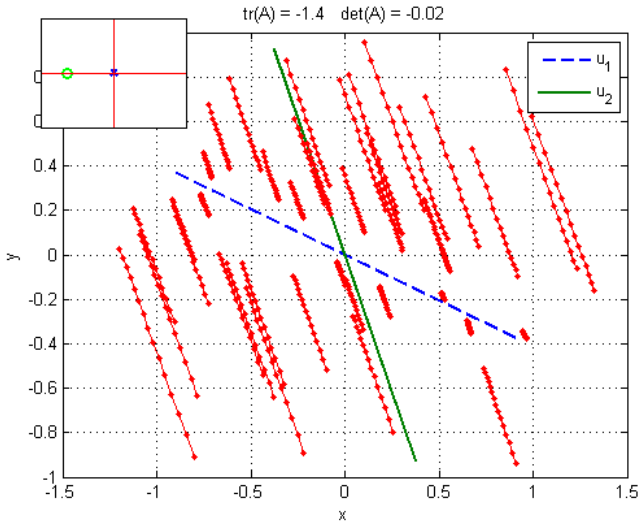
for u=-1



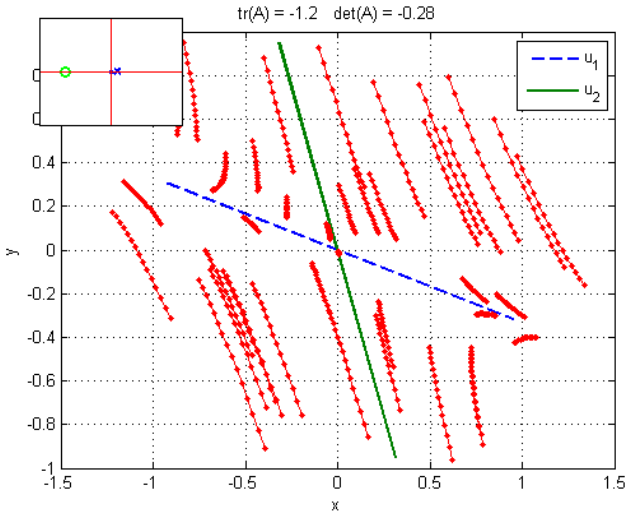
for u=-0.9



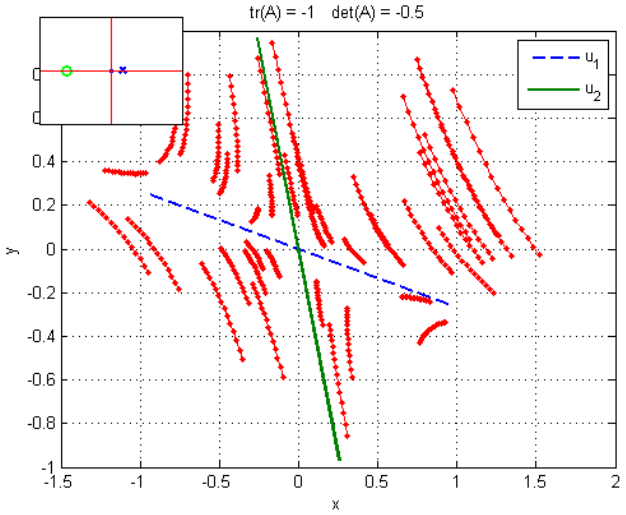
for u=-0.8



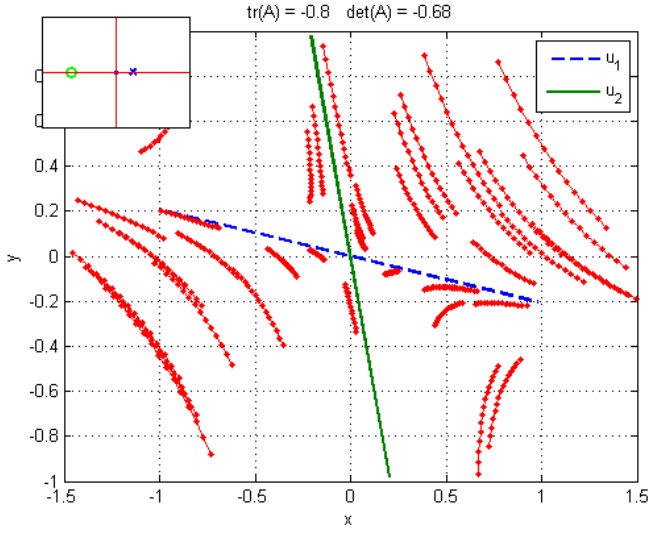
for u=-0.7



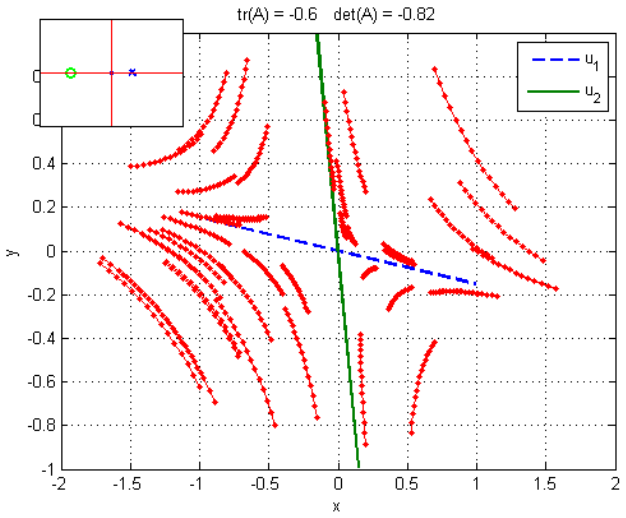
for u=-0.6



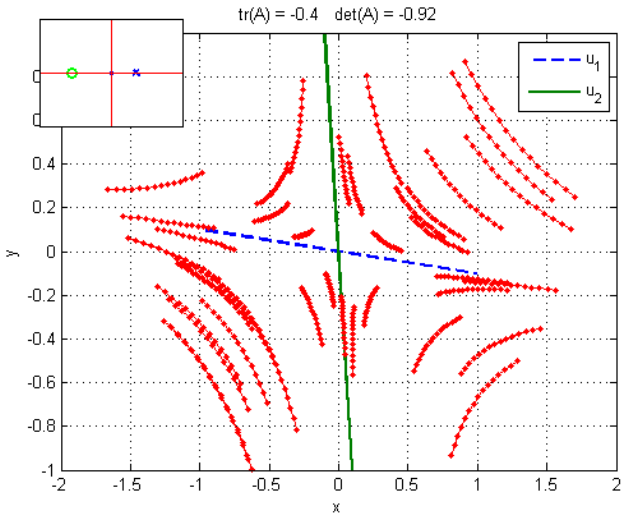
for u=-0.5



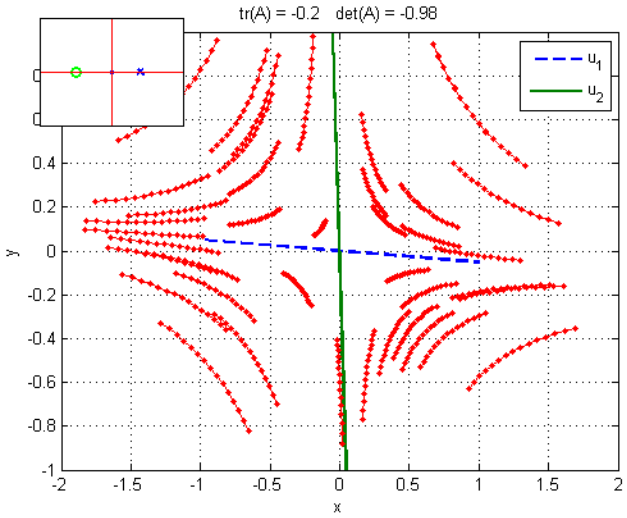
for u=-0.4



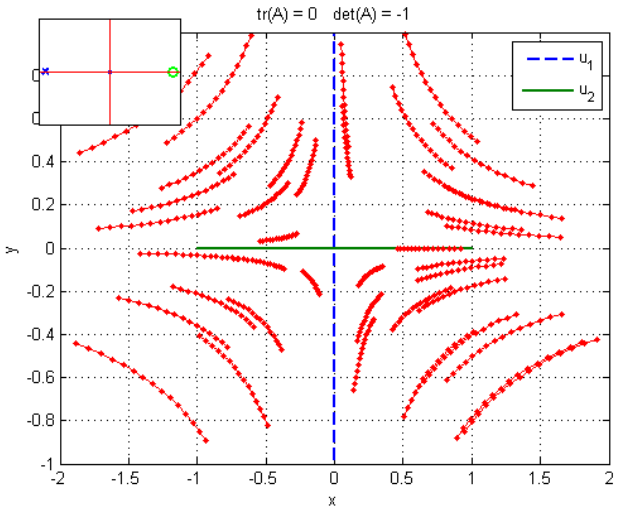
for u=-0.3



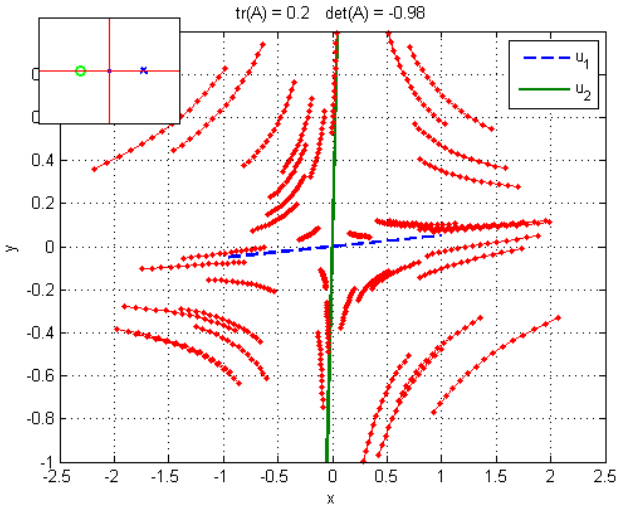
for u=-0.2



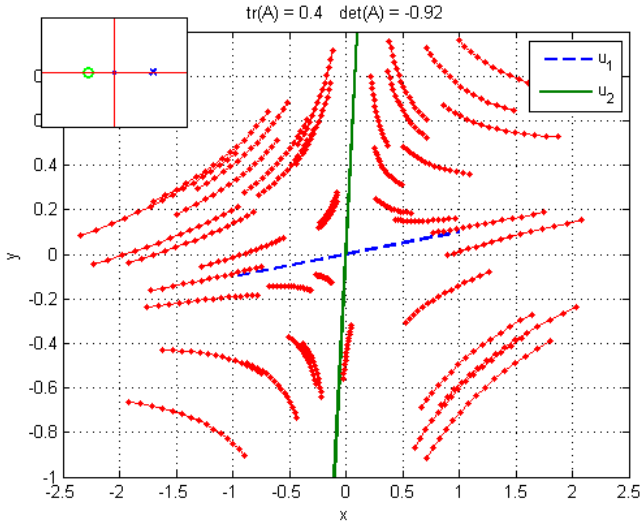
for u=-0.1



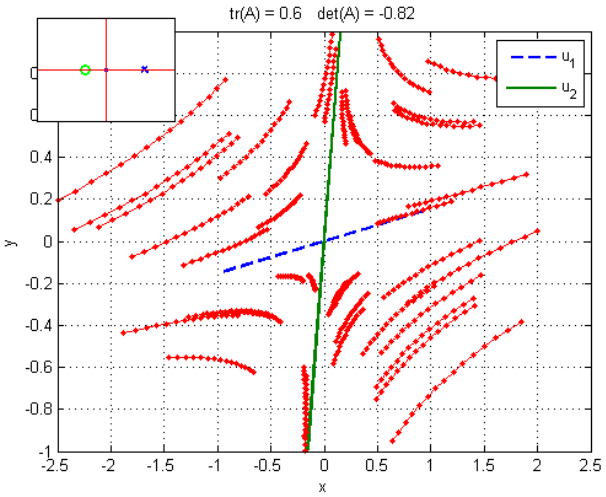
for u=0



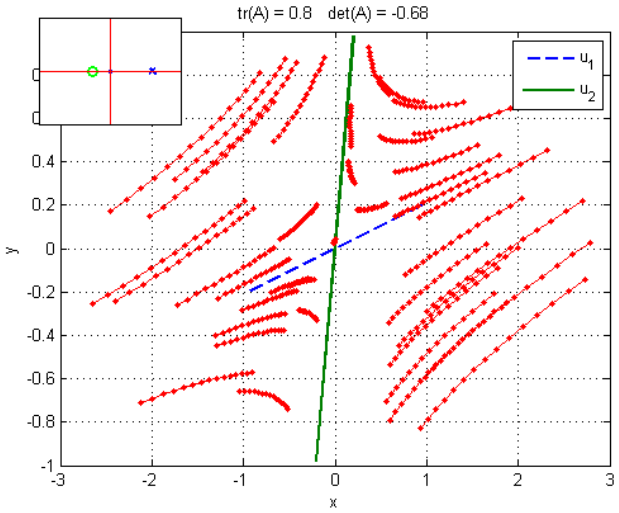
for u=0.1



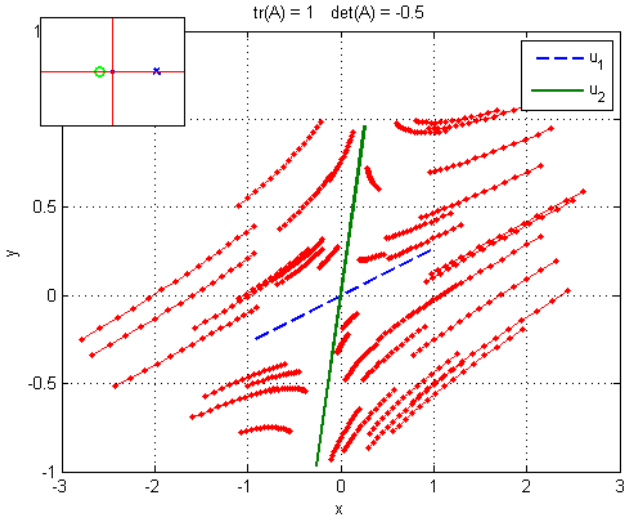
for u=0.2



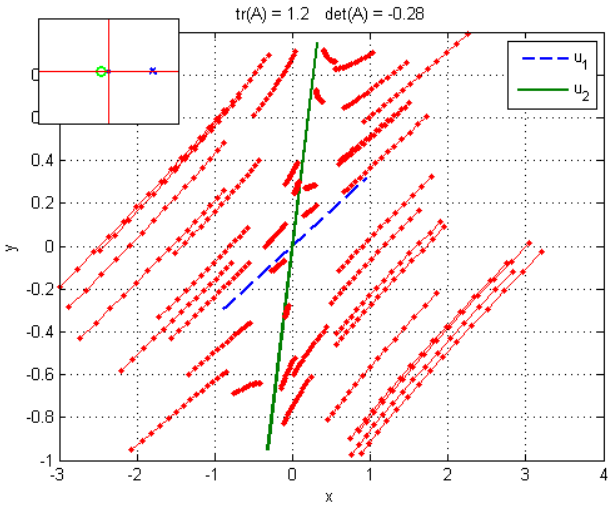
for u=0.3



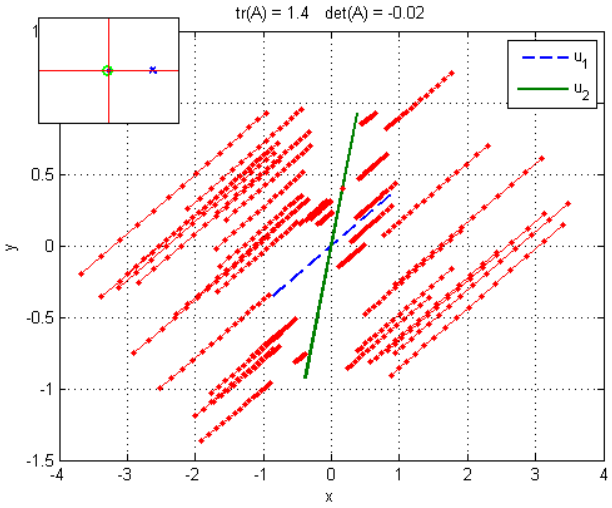
for u=0.4



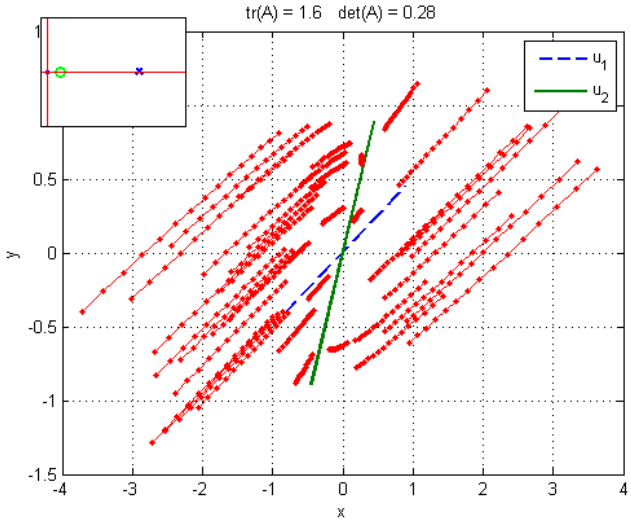
for u=0.5



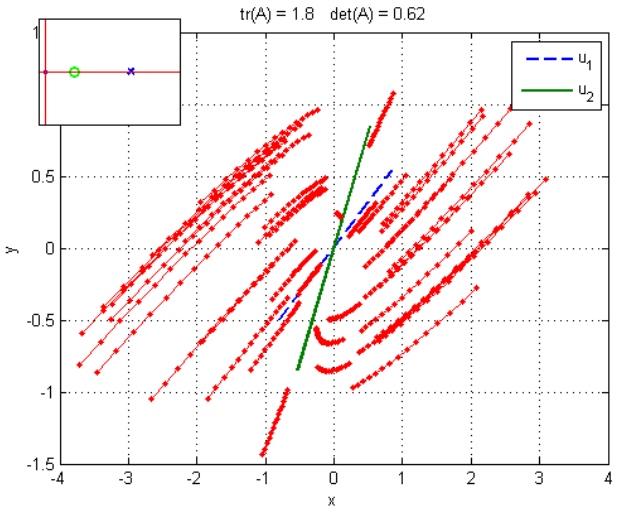
for u=0.6



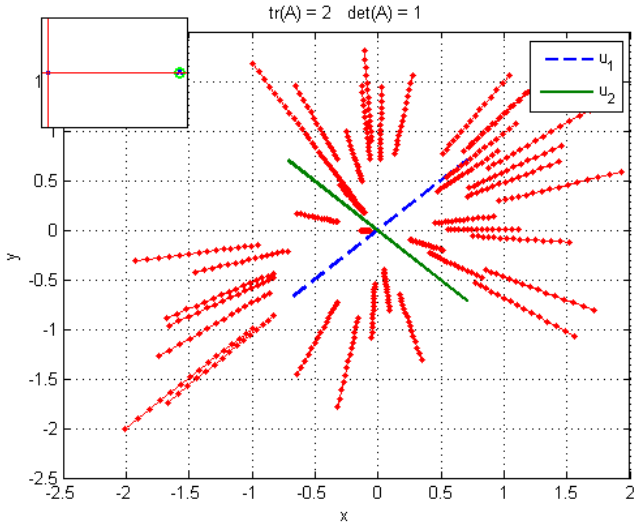
for u=0.7



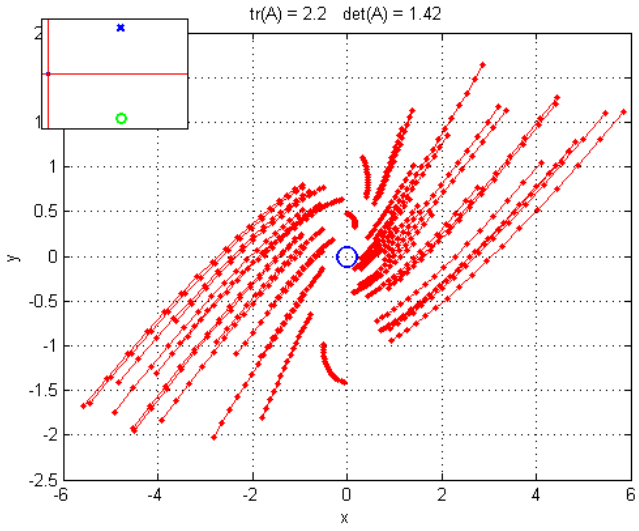
for u=0.8



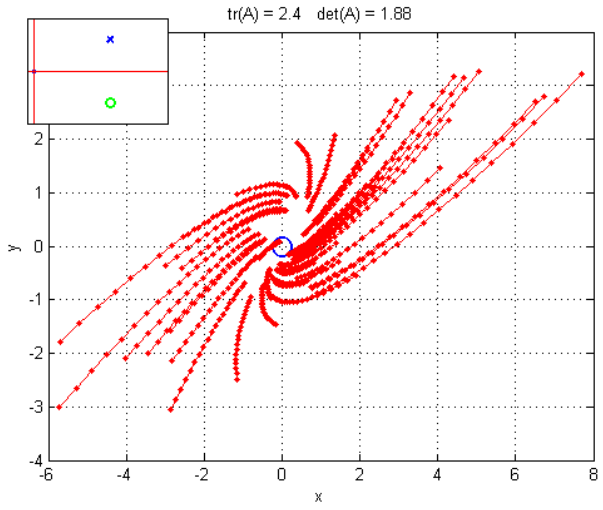
for u=0.9



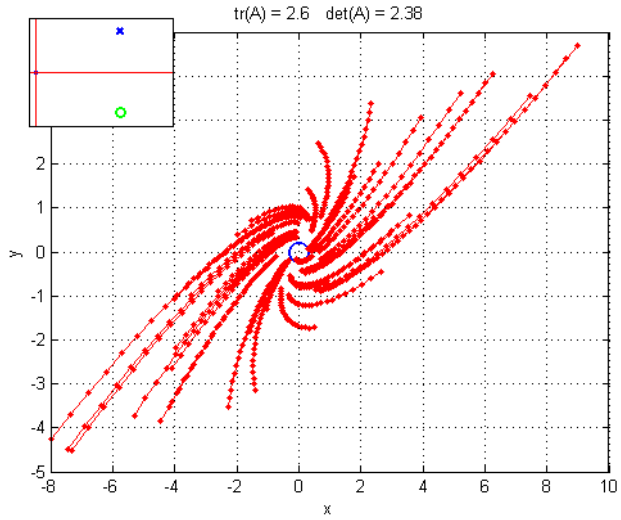
for u=1



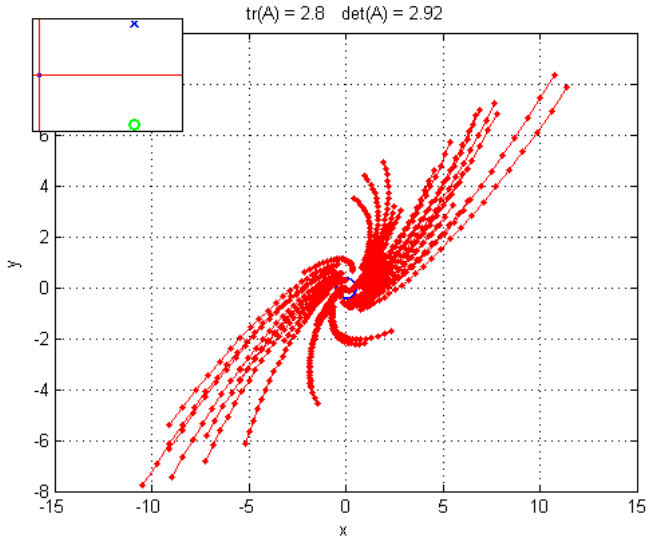
for u=1.1



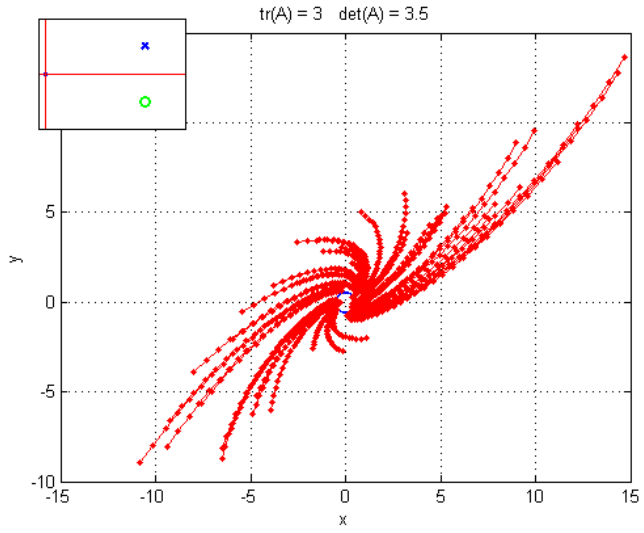
for u=1.2



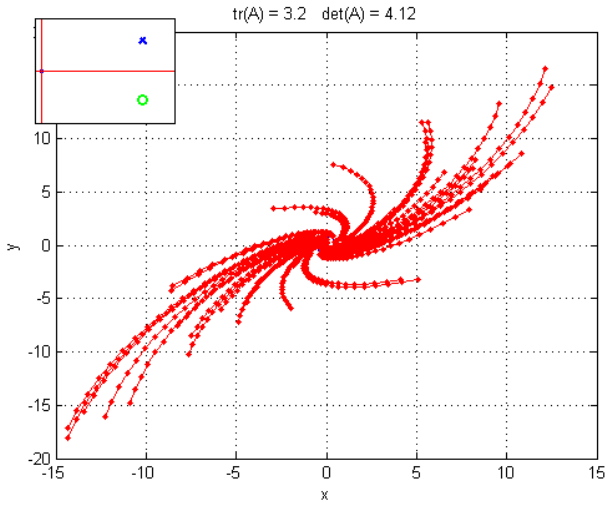
for u=1.3



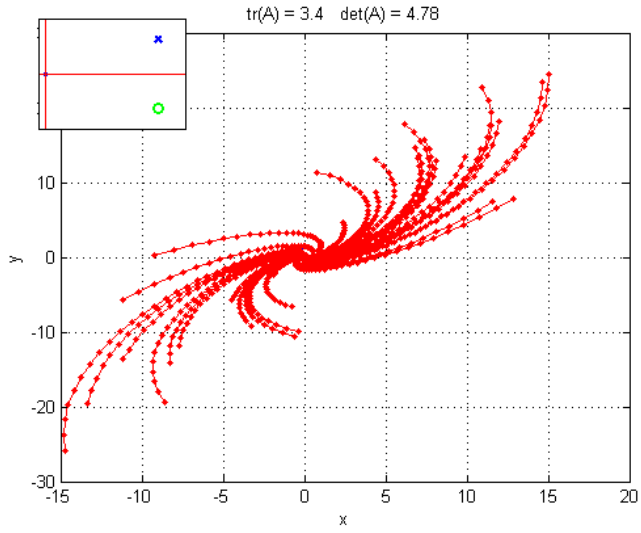
for u=1.4



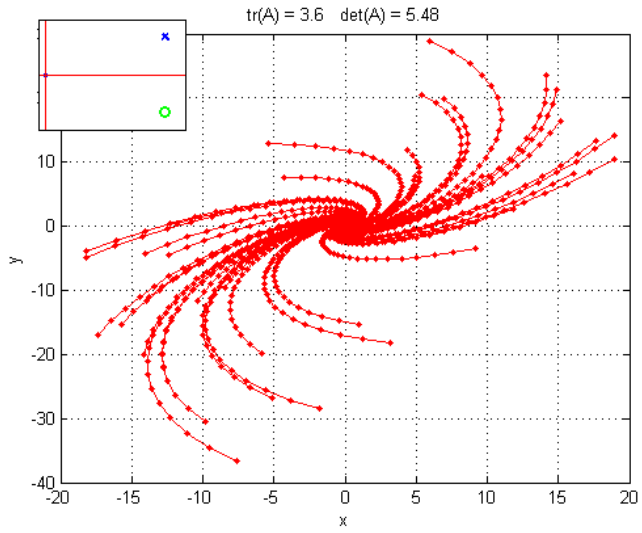
for u=1.5



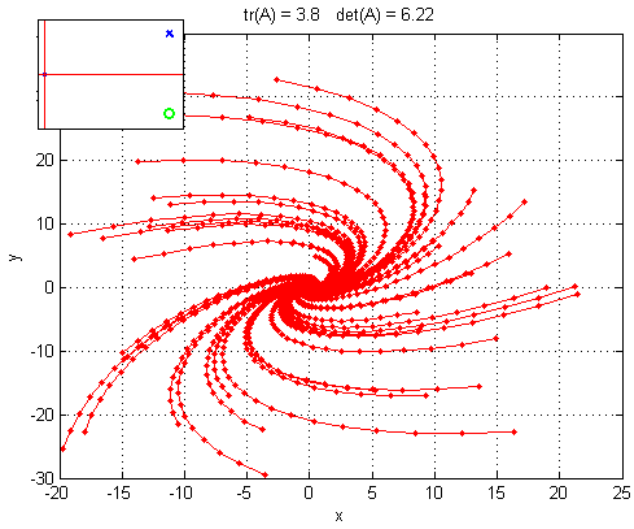
for u=1.6



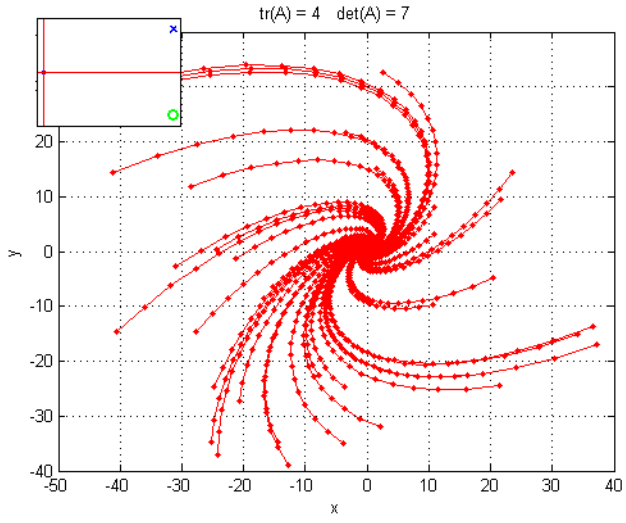
for u=1.7



for u=1.8



for u=1.9



for u=2

At u=-2 the phase plane is a spiral sink and as u increases to -1 it slowly straightens out to a radial sink. At u goes from -1 to about -0.8 the phase plane is a nodal sink. As u goes from that to 0 it is a saddle and continues to be a saddle, just on a tilt in the other direction until u reaches about 0.8 where the phase plane is then a nodal source. At u=1 it is a radial source and from 1 to 2 it is a spiral source.