DynaLands

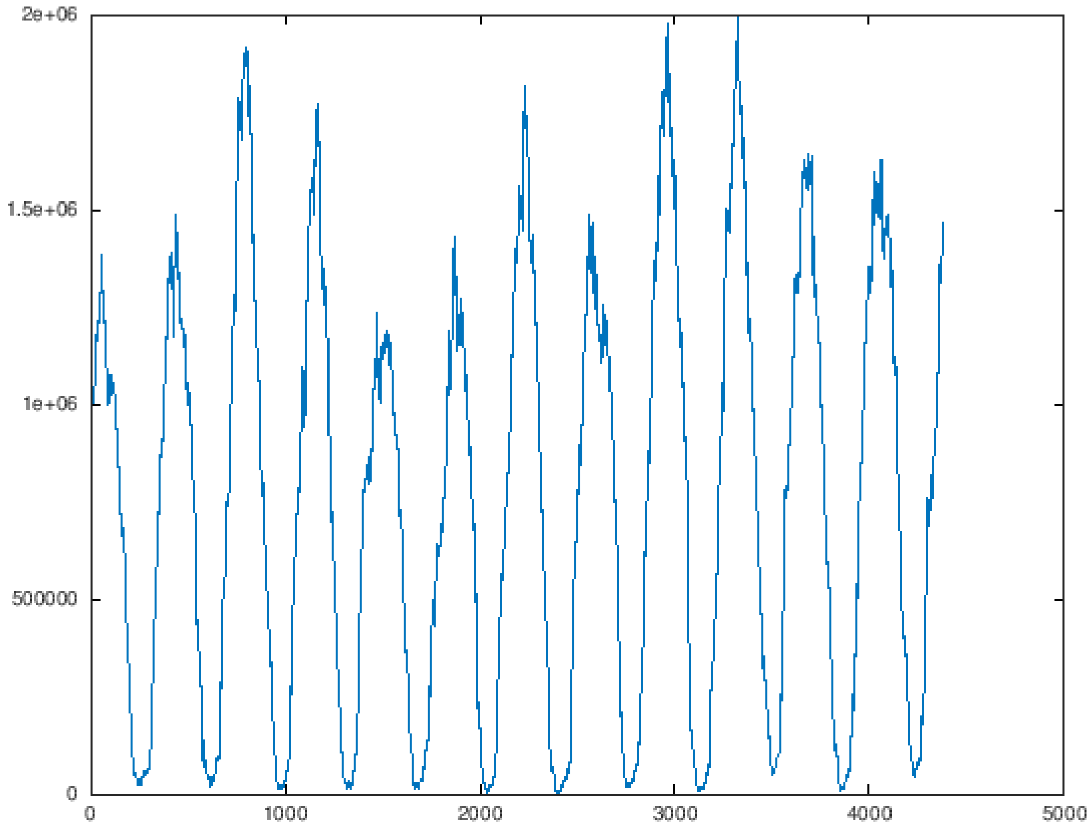
February 8, 2018

```
In [3]: %Dynamic landscapes are everywhere

        from IPython.display import HTML
        HTML('<iframe width="1280" height="720" src="https:
             //www.youtube.com/embed/VIxciS1B9eo"
             frameborder="0" allow="autoplay; encrypted-media" allowfullscreen></iframe>')

Out[3]: <IPython.core.display.HTML object>
```

```
In [1]: %Importing icecover data to understand biodiversity dynamics ---
        %data from http://nsidc.org/data/masie
        A = dlmread("masie_4km_allyears_extent_sqkm.csv",",");
```

```
In [2]: A(1:10,1:6)

ans =

   0.0000e+00   0.0000e+00   0.0000e+00   0.0000e+00   0.0000e+00   0.0000e+00
   0.0000e+00   0.0000e+00   0.0000e+00   0.0000e+00   0.0000e+00   0.0000e+00
   2.0060e+06   1.3035e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
   2.0060e+06   1.3035e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
   2.0060e+06   1.3171e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
   2.0060e+06   1.3410e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
   2.0060e+06   1.3417e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
   2.0060e+06   1.3466e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
   2.0060e+06   1.3511e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
   2.0060e+06   1.3537e+07   1.0697e+06   9.6601e+05   1.0871e+06   8.9777e+05
```

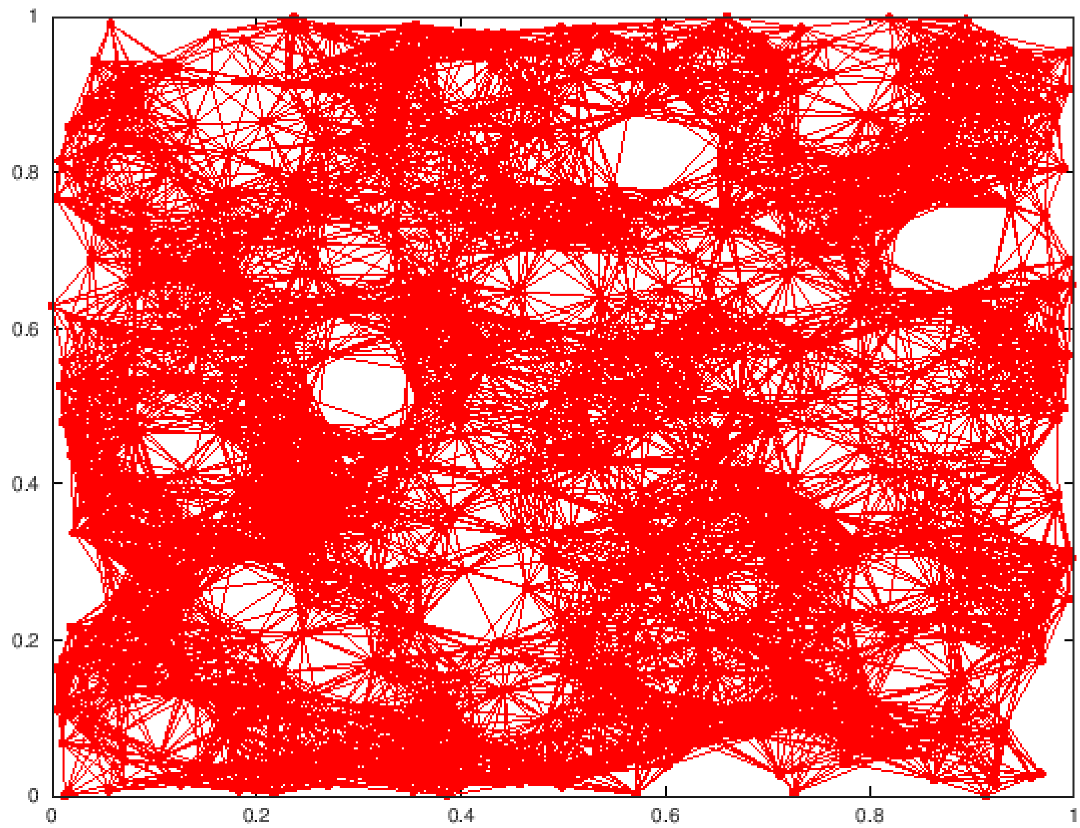
```
In [3]: %Amplitude and frequency in ice cover -- x time and y ice cover in km2
        plot(A(:,10))
```




```
In [4]: %We will use the fluct in ice cover as a proxy of habitat
        %and connectivity dynamics
        %RGG %Quick code Carlos J Melian
        %November 2013
        J = 1000;r = 0.1;%r = unifrnd(0.01,1);
        D = zeros(J,J);

        %Asymptotic behavior
        mu = J*(e^(-pi * r^2 * J))
        MA = log(J) - log(mu);
        MB = pi*J;
        rc = sqrt(MA/MB);


        n = unifrnd(0,1,J,2);
        for i = 1:J-1;
             for j = i+1:J;
                 A = (n(i,1) - n(j,1))^2;%Euclidean distance
                 B = (n(i,2) - n(j,2))^2;
                 d(i,j) = sqrt(A + B);
                 if d(i,j) < r;
```

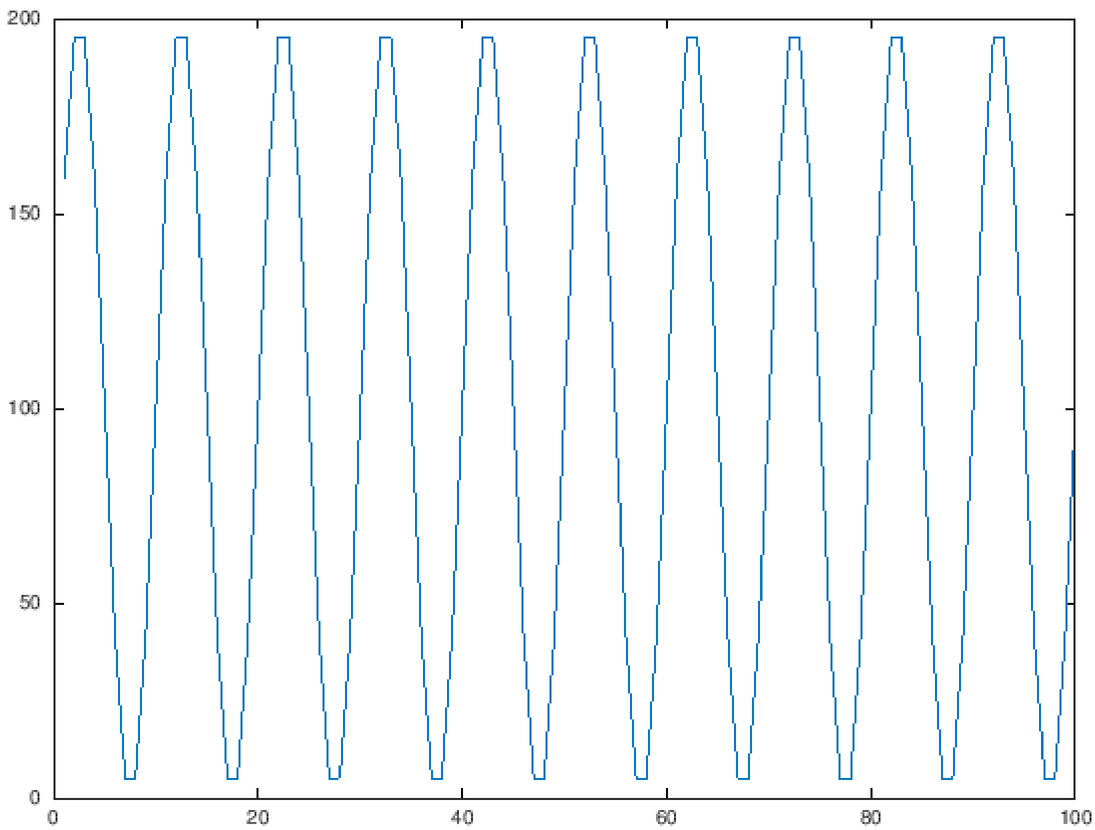
```
            D(i,j) = 1;
         else
            D(i,j) = 0;
         end
     end
end
D1=D+D';

%plot network
gplot(D1,n, "r.-")
set (get (gca, ("children")), "markersize", 12);
```

```
mu =    2.2711e-11
```



```
In [5]: %the distance to connect two sites is function of a sinusoidal function
        show=true;
          showEach = 1;
          for ri = 1:1,
            S = 10;J = 100;%S sites and J inds. per site
```

```
%1. Implement a general case with zero-sum dynamics
%combining static-dynamic vs. symmetric-asymmetric scenarios
%(non-stationary Gillespie later)
%Be sure that the mij + lambda + nu == 1
%-----------------------------------------------------------
n = unifrnd(0,1000,S,2); %sites!
R = ones(S,J);
countgen = 0;
Pairs = zeros(1,2);cevents = 0;
newSp = 1;
gamma=[];
for k = 1:100,  %Generations...
    A = 200;%amplitude, is the peak deviation:
    %350 to match simulations in random landscapes
    f = 0.1;%ordinary frequency, number of
    %cycles that occur each second of time
    sig = 0;%the phase
    countgen = countgen + 1;
    %r = A*sin(2*pi*f*countgen + sig) + A;%starting point with r approx.
    r(k,1) = A/2*(sin(2*pi*f*countgen + sig)+1);
end
v=1:100;
plot(v,r)
end
```

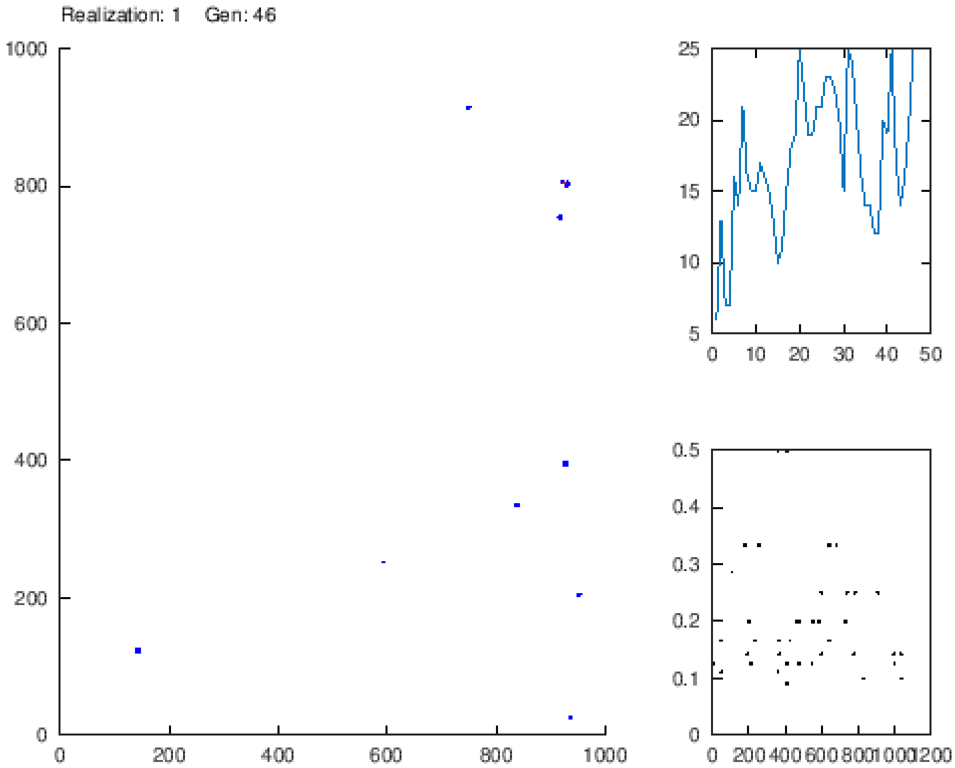


In [8]:
```
%------------------------------------------------------------------------
%General dynamic landscapes
%Melian@KB May 2017
%Palamara&Melian June 2017 version from scratch
%Alex Rozenfeld June 2017
%------------------------------------------------------------------------
  show=true;
  showEach = 1;
  for ri = 1:50,
    S = 10;J = 100;%S sites and J inds. per site

    %1. Implement a general case with zero-sum dynamics
    %combining static-dynamic vs. symmetric-asymmetric scenarios
    %(non-stationary Gillespie later)
    %Be sure that the mij + lambda + nu == 1
    %-------------------------------------------------------
    n = unifrnd(0,1000,S,2); %sites!
    R = ones(S,J);
    countgen = 0;
    Pairs = zeros(1,2);cevents = 0;
    newSp = 1;
    gamma=[];
    for k = 1:100,  %Generations...
        A = 200;%amplitude, is the peak deviation:
        %350 to match simulations in random landscapes
        f = 0.1;%ordinary frequency, number of
        %cycles that occur each second of time
        sig = 0;%the phase
        countgen = countgen + 1;
        %r = A*sin(2*pi*f*countgen + sig) + A;%starting point with r approx.
        r = A/2*(sin(2*pi*f*countgen + sig)+1);

        %2. Check sinusoidal with boundary conditions considering continuous A and f
        %Check r_min == 0 and r_max == max distance ij

        D = zeros(S,S);%theshold matrix
        Di = zeros(S,S);%distance matrix
        mu = S*(exp((-pi * (r/1000)^2 * S)));%site connectivity


        for i = 1:S-1,
            for j = i+1:S,
                A = (n(i,1) - n(j,1))^2;%Euclidean distance
                B = (n(i,2) - n(j,2))^2;
                d(i,j) = sqrt(A + B);
```

```
        Di(i,j) = 1/d(i,j);

        %3. This is the simplest kernel
        %Explore the asymmetry under 1/d(i,j)
        %Do we need to implement more asymmetric situations, like 1/(d(i,j)^x)

        if d(i,j) < r;%threshold
           D(i,j) = 1;
        else
           D(i,j) = 0;
        end
   end
end
%DI=Di+Di';Dc=cumsum(DI,2);D1=D+D';
DI=Di+Di';
D1=D+D';
DI=DI.*D1;  %<========ALEX
Dc=cumsum(DI,2);

m = unifrnd(0.001,0.1,1);  %migraion from the blocks
v = unifrnd(0.0001,0.01,1);%regional migration?
l=1-(m+v);

for j = 1:J*S,  %MonteCarlo Time
    KillHab = unidrnd(S);
    KillInd = unidrnd(J);
    ep=unifrnd(0,1,1);  %event probability
    if ep < m,  %Migration
      MigrantHabProb = unifrnd(0,max(Dc(KillHab,:)));
      MigrantHab = find(Dc(KillHab,:) >= MigrantHabProb);
    %pause
      if D1(KillHab,MigrantHab) == 1;
       %4. Implement local birth dynamics and speciation dynamics

       MigrantInd = unidrnd(J);
       cevents = cevents + 1;
       Pairs(cevents,1) = KillHab;
       Pairs(cevents,2) = MigrantHab(1,1);

       R(KillHab,KillInd)=R(MigrantHab(1,1),MigrantInd);
      end
    elseif ep <= m+v,  %mutation
       newSp = newSp +1;
       R(KillHab,KillInd) = newSp;
    else               %birth
       BirthLocalInd = unidrnd(J);
       while BirthLocalInd == KillInd,
         BirthLocalInd = unidrnd(J);
```

```
                end
                R(KillHab,KillInd) = R(KillHab,BirthLocalInd);
            end
        end
        %Species at each site:

        Sp_eachSt=arrayfun(@(ix) unique(R(ix,:)), [1:size(R,1)],'uniformoutput',false)
        %alpha(g) Num of species at each site for present generation
        alpha = arrayfun(@(v) length(cell2mat(v)),Sp_eachSt);
        gamma(countgen) = numel(unique(R));


        Sim=CalcSim(Sp_eachSt,S);




        if show && (k==1 || mod(k,showEach)==0), %Show results
          ShowResults(ri,countgen,S,n,D1,d,alpha,gamma,Sim)

        end
    end
  end

end

function Sim = CalcSim(Sp_eachSt,S)
  Sim = zeros(S,S);
  for i = 1:S-1,
     for j = i+1:S,
        %CantSpEnComun_ij = #(Sp_i n Sp_j)
        %Similaridad_ij= CantSpEnComun_ij / (#Sp_i + #Sp_j - CantSpEnComun_ij)
        CantSpEnComun_ij = length(intersect(Sp_eachSt{i},Sp_eachSt{j}));
        Sim(i,j)= CantSpEnComun_ij / (length(Sp_eachSt{i})+length(Sp_eachSt{j})-CantSpE
     end
  end
  Sim = Sim + Sim' + eye(S,S);
end

function ShowResults(ri,countgen,S,n,D1,d,alpha,gamma,Sim)
          sizeFactor=10;
          figure(ri)
          subplot(2,3,[1 2 4 5]) %alpha

          hold off
          for i=1:S,
            scatter(n(i,1),n(i,2),sizeFactor*alpha(i),'b','filled') %Sites
            hold on;
            hola=1;
```

```
  ixStConnected=find(D1(i,:));
  for ix=ixStConnected,
    line([n(i,1) n(ix,1)]',[n(i,2) n(ix,2)]','color','r') %Links
  end
end
xlim([0 1000])
ylim([0 1000])
text(1,1050,['Realization: ' num2str(ri) '    Gen: ' num2str(countgen)])


subplot(2,3,3)  %gamma
plot(gamma);
%hold on
%scatter(countgen,gamma(countgen),5,'k')

subplot(2,3,6) %Sim VS d (connected and non connected)
hold off
for i = 1:S-1,
   for j = i+1:S,
      scatter(d(i,j),Sim(i,j),5,'k')
      hold on
   end
end
pause(0.001);
end
end
```



In [1]:
```
% ...in the end we want to understand the circadian clock of
% biodiversity dynamics

from IPython.display import Image
Image("circadianclock.png")
```

Out[1]: