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Discrete k-nearest neighbor resampling for simulating multisite precipitation occurrence and model adaption to climate change

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```
function [DisSim]=Discrete_KNNR(BinHis,Para)
%% Simulate Discrete Values (Binary Process) using KNNR
% Input
%       Para.kweight: Weight probability
%       Para.knum: K number
%       Para.Nsim: Number of simulation
%       Parameters required for Genertic Algorithm
%       Para.GA.is=true; % if true, GA process is executed.
%       Para.GA.prob.cross=0.1; % Crossover probability
%       Para.GA.prob.mut=0.001; % Mutation probability
%       BinHis: Historical Binary Data
% Output:
%       DisSim: number of simulation

    sz=size(BinHis);
    S = DiscrteSimWeight(Para.kweight,Para.Nsim);

    BinC=BinHis(unidrnd(sz(1)),:);
    SBinH=sum(BinHis(1:sz(1)-1,:),2);
    ZindH=find(~SBinH);nZindH=length(ZindH);

    for is=1:Para.Nsim
        if(Para.GA.is)
            set1=sel_Bin_knn(BinHis,BinC,S(is),ZindH,nZindH,sz);
            if(sum(set1)~=0)
                set2=sel_Bin_knn(BinHis,BinC,S(is),ZindH,nZindH,sz);
                DisSim(is,:)=GA_Mix(set1,set2,Para,BinC);
            else
             DisSim(is,:)=set1;
            end
        else
            DisSim(is,:)=sel_Bin_knn(BinHis,BinC,S(is),ZindH,nZindH,sz);
        end
            BinC=DisSim(is,:);
    end

%%
function [B1]=sel_Bin_knn(BinHis,BinC,Ssel,ZindH,nZindH,sz)
% Selecting multisite occurrence from observed data
% Input:
%    BinHis: Observed Occurrence
%    BinC: Current state of Occurrence
% Output:
%    B1: Selected Occurrence

    if sum(BinC)~=0
```

```
        DistC=sum(abs(BinHis(1:sz(1)-1,:)-repmat(BinC,sz(1)-1,1)),2);
        sDistC=sort(DistC);
        temp1=find(sDistC(Ssel)==DistC);
        B1=BinHis(temp1(unidrnd(length(temp1)))+1,:);
    else % when all the values are zero
        B1=BinHis(ZindH(unidrnd(nZindH))+1,:);
    end

%%
function [Set_out]=GA_Mix(Set1,Set2,Para,BinC)
% GA mixing
% Input:
%   Set1 and Set2 : two selected binary precipitation dataset
%   BinC: Current Occrrence dataset
% Output:
%   Set_out: Mixed occurrence precipitation

    Set_out=Set1;
    sel_cross=Para.GA.prob.cross>rand(Para.N.stations,1);

    if sum(sel_cross)
        for is=1:length(sel_cross)
            if (sel_cross(is) & Set2(is))
                Set_out(is)=Set2(is);
            end
        end
    end

    is_Mut=rand(Para.N.stations,1)<Para.GA.prob.mut;
    a=find(is_Mut);

     if(length(a))
         for it=1:length(a)
             if(BinC(a(it)))
                 Set_out(a(it))=1;
             else
                Set_out(a(it))=~Set_out(a(it));
             end
         end
     end

%% Simulating Discrete Weight random number
function S = DiscrteSimWeight(p,ns);
% Input:
%     p: probability matrix
%     ns: number of data to simulate
% Output:
%     S: ns*1 vector simulated
    cdf = cumsum(p);  % cdf is a vector
    for i = 1:ns
         u = rand;
         k = 1;
         while u > cdf(k)
            k = k+1;
         end
         S(i) = k;
    end
```