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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 = DiscreteSimWeight(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

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        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 Occurrence 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

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% 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
```