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function FX = fitnessFunctionF(vh,vs,chromosome)
% THIS FUNCTION CALCULATES THE FITNESS FUNCTION F(X) DESIGN
% MEASURE. THIS FUNCTION SHOULD BE USED THROUGH THE BILEVEL OPTIMIZATION
% ALONG WITH THE SECOND FITNESS FUNCTION f(X)
% FOR THE FORMULA, SEE EQUATION 8
%
% INPUT:  [NxN DOUBLE]  CCF ARRAY DEFINED AS  $v^s$  IN THE EQUATION
%         [NxN DOUBLE]  CCF ARRAY DEFINED AS  $v^h$  IN THE EQUATION
%         [1xN DOUBLE]  DESIGN CHROMOSOME VECTOR
% OUTPUT: [1x1 DOUBLE]  FIRST NUMERATOR TERM CALCULATED FOR THE F(X)
%                  DESIGN MEASUREMENT
%
% ENGINEERS: JAMES S COLLINS
%            BEN DUSSALT
%            NAMKHA NORSANG
%            NISHANTH KATHIRVEL
%
% PROJECT: ME 6101 GREEN MODULAR DESIGN GROUP PROJECT
% DATE: NOVEMBER 2017
% LOCATION: GEORGIA INSTITUTE OF TECHNOLOGY. ATL, GA
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[~,binChromosomeArray,~,m]=chromoSort(chromosome);

[FNT1,m]=FNumerator1(vh,vs,m,binChromosomeArray);
[FNT2,~]=FNumerator2(vh,vs,m,binChromosomeArray);

FX=(FNT1-FNT2)/m;

end

function [FNumeratorTerm1,numtest1] = FNumerator1(vh,vs,m,chromArray)
% THIS FUNCTION CALCULATES THE FIRST NUMERATOR TERM OF THE F(X) DESIGN
% MEASURE. THIS FUNCTION ALONG WITH FNumerator2 SHOULD BE USED THROUGH THE
% BILEVEL OPTIMIZATION
% FOR THE FORMULA, SEE EQUATION 8
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% SETTING THE COMPONENT NUMBER
n=37;
% DECLARING ITERATION VARIABLES
FNumeratorTerm1=0;
numo=0;
denom=0;
numo2=0;

numtest1=[];
% STARTING FIRST, EXTERIOR SUMMATION FOR LOOP
for k=1:1:m
    chkRow = sum(chromArray(k,:));

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        if chkRow~=0

            % TWO NESTED SUMMATION THAT MAKE UP THE NUMERATOR FOR THE TERM
            for i=1:1:n
                for j=1:1:n
                    % PRODUCT OF INDEXED VALUES ON THE NUMERATOR
                    % INCLUDED IN THE DOUBLE SUMMATION
                    v1=vh(i,j);
                    v2=vs(i,j);
                    x1=chromArray(k,i);
                    x2=chromArray(k,j);

                end
            end
            numo = numo2;
            numo2 = 0;
            % THIS BLOCK DEFINES THE SQUARED
            % SUMMATION TERM IN THE DENOMINATOR
            for l=1:1:n
                denom=denom+chromArray(k,l);
            end
            denom=(denom)^2;
            % EXTERNAL SUMMATION
            FNumeratorTerm1=FNumeratorTerm1+(numo/denom);
            denom = 0;
        end
    end
end

function [FNumeratorTerm2,numotest2] = FNumerator2(vh,vs,m,chromArray)
% THIS FUNCTION CALCULATES THE SECOND NUMERATOR TERM OF THE F(X) DESIGN
% MEASURE. THIS FUNCTION ALONG WITH FNumerator2 SHOULD BE USED THROUGH THE
% BILEVEL OPTIMIZATION
% FOR THE FORMULA, SEE EQUATION 8
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

n=37; % SETTING THE COMPONENT NUMBER
FNumeratorTerm2=0; % DECLARING ITERATION VARIABLES
numo2=0;
denom=0;

numotest2=[];
% STARTING FIRST, EXTERIOR SUMMATION FOR LOOP
for k=1:1:m
    chkRow = sum(chromArray(k,:));
    if chkRow~=0

        % TWO NESTED SUMMATION THAT MAKE UP THE NUMERATOR FOR THE TERM
        for i=1:1:n
            for j=1:1:n
                % PRODUCT OF INDEXED VALUES ON THE NUMERATOR
                % INCLUDED IN THE DOUBLE SUMMATION
                v1=vh(i,j);
                v2=vs(i,j);
                x1=chromArray(k,i);
                x2=abs(1-(chromArray(k,j)));
            end
        end
    end
end

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        end
    end
    numo = numo2;
    numo2 = 0;
    % THIS BLOCK DEFINES THE SQUARED
    % SUMMATION TERM IN THE DENOMINATOR
    for l=1:1:n
        denom=denom+chromArray(k,l);
    end
    denom=(n-denom)^2;
    % EXTERNAL SUMMATION
    FNumeratorTerm2=FNumeratorTerm2+(numo/denom);
    denom = 0;
end
end
end

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