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%David Melanson
clf reset; clearvars; clc
pausetime = 0;
pauseflag = 0;
maxw = 10;
minw = 0;
%Problem definition - bipolar AND function

%define three 4 element input vectors -- one element in a vector for each
%state
P = [
    1 1 -1 -1;          %X1
    1 -1 1 -1;          %X2
    1 1 1 1             %Bias
];

%each row is one input set
%each column is one set of training data for network
%define 4 1-element output vectors
% Ni01 Ni02 Ni03 Ni04
T = [1 -1 -1 -1];

%Initialize network
%=====
[R, Q] = size(P); [S, Q] = size(T);
W0 = zeros(S, R);
B0 = ones(S, 1);
fprintf('R =%2i Q =%2i S =%2i\n', R, Q, S);

% Plot original values
%=====
disp(['pause for ', num2str(pausetime), 'sec']);
pause(pausetime);
figure(1);
hintonw(W0, maxw, minw);
title('Original Weights W(i,j)');

% TRAIN THE NETWORK
%=====
% TRAINING PARAMETERS
disp_freq = 1;
max_epoch = 4;
% lr = 0.1;
% dr = lr/3;
% lp Learning Parameter
% lr Learning Rate
% dr Decay Rate
lr = 1;
lp.lr = lr;
lp.dr = 0;

W = W0;
B = B0;

for epoch = 1:max_epoch
    for q = 1:Q
        % PRESENTATION PHASE
        A = T(:, q);
        % LEARNING PHASE

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        dW = learnhd(W, P(:, q), [], [], A, [], [], [], [], [], lp, []);
        fprintf("\npause\n");
        W = W + dW;
        fprintf('input = %2i W = %2i %2i %2i', epoch, W)
        if pauseflag == 1
            pause(pausetime)
            figure(1)
        end
    end
    % DISPLAY PROGRESS
    if rem(epoch, disp_freq) == 0
        pause(pausetime)
        hintonw(W, maxw, minw)
        title('Weights W(i,j)');
    end
end

% PLOT FINAL VALUES
hintonw(W, maxw, minw);
title('Final Weights W(i,j)');
pause(pausetime);

% SUMMARIZE RESULTS
%=====
fprintf("\nWith inputs of \n%2i %2i %2i\n%2i %2i %2i\n%2i %2i %2i\n%2i %2i %2i\n", P);
disp("")
fprintf("The network applies weights of %2i %2i %2i.\n", W)
A_nonbin = hardlims(W*P);
A_bin = hardlim(W*P);
disp('The network responds with binary outputs')
disp(A_bin)
disp('Thus the network succesfully replicated an AND gate.')

%input, target, and output are necessary for submission of HW

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R = 3 Q = 4 S = 1
 pause for 0sec

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pause
input = 1 W = 1 1 1
pause
input = 1 W = 0 2 0
pause
input = 1 W = 1 1 -1
pause
input = 1 W = 2 2 -2
pause
input = 2 W = 3 3 -1
pause
input = 2 W = 2 4 -2
pause
input = 2 W = 3 3 -3
pause
input = 2 W = 4 4 -4
pause
input = 3 W = 5 5 -3
pause
input = 3 W = 4 6 -4
pause

```

```

input = 3 W = 5 5 -5
pause
input = 3 W = 6 6 -6
pause
input = 4 W = 7 7 -5
pause
input = 4 W = 6 8 -6
pause
input = 4 W = 7 7 -7
pause
input = 4 W = 8 8 -8

```

With inputs of

```

1 1 1
1 -1 1
-1 1 1
-1 -1 1

```

The network applies weights of 8 8 -8.

The network responds with binary outputs

```

1 0 0 0

```

Thus the network succesfully replicated an AND gate.

