```matlab
clear all;
close all;
```

Winnow Algorithm Sample Complexity

```matlab
% Setup & initialise variables:
n = 100; % largest number of dimensions.
m = 1000; % number of test data point used for each error estimation.
loop = 20; % number of runs per dimension.
GenErrLim = 0.1; % point where 10% error reached as per handout
 definition
NumSamples = zeros(n, loop); % initialise Sample Complexity variable

for i = 1:n    % change size of column of data set

    for l = 1:loop

        % generate test and training data  from a uniformly randomly
        % generated data set ([-1,1]^n)

        trainX = randi([0 1], m, i); %uniform random set of [0,1]
        testX = randi([0 1], m, i);

        trainY = trainX(:, 1); %select first column
        testY = testX(:, 1);

        Counter = 0; % sample complexity counter
        GenErr = 1000; % start by setting at an artificially high
number


        while(GenErr > GenErrLim)
            % Keep track of the number of training samples used in the
 loop:
            Counter = Counter + 1;

            % train winnow (find weight vector)
            w = winnowtrain(trainX(1:Counter,:),
 trainY(1:Counter, :));

            % test winnow (apply leaned weight to test data)
            yP = ((testX * w) -i >= 0); % if able miss-match set to 0

            % errors (count miss-classification instances):
            loss = sum(yP ~= testY);
            GenErr = (loss)/m/2;
             % calculate the generalisation error estimate as a
proportion
             % of the amount of test data instances (m).
        end

        % sample complexity as a function of the n dimension of data:
```
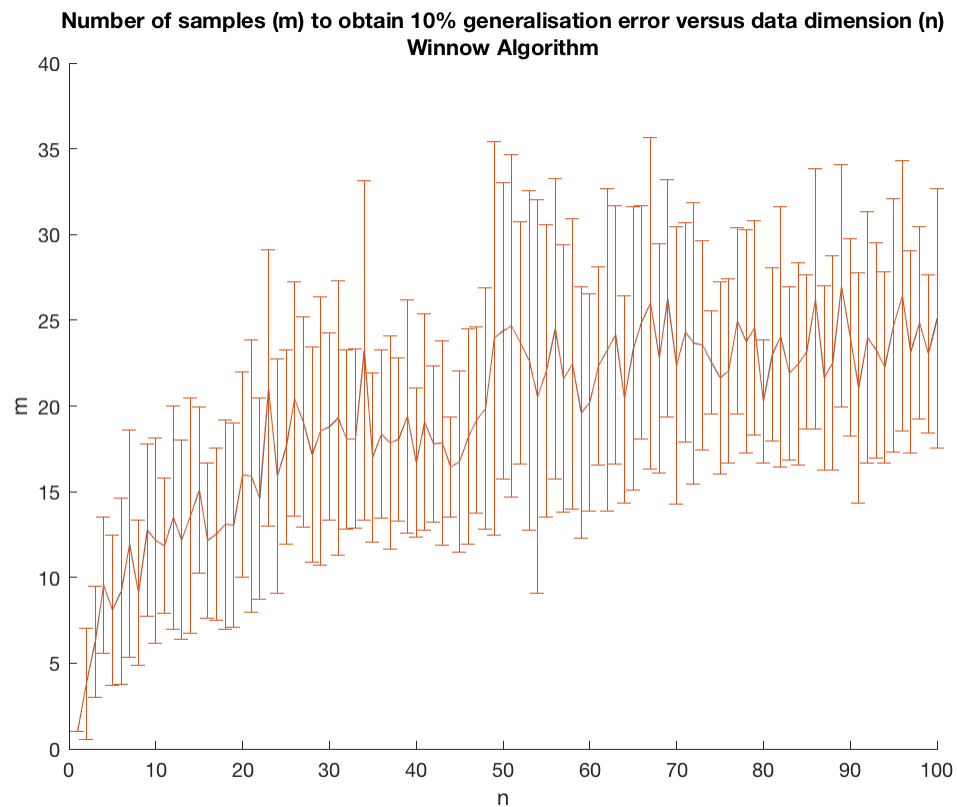
```
        NumSamples(i,l) = Counter;
    end
end

% calculate means and standard deviations of number of samples needed
meanNumSamples = mean(NumSamples,2);
sdNumSamples = std(NumSamples,[],2);

figure;
hold on;
plot(meanNumSamples)
title({'Number of samples (m) to obtain 10% generalisation error
 versus data dimension (n)','Winnow Algorithm'});
ylabel('m');
xlabel('n');
errorbar(1:n, meanNumSamples, sdNumSamples);
hold off;
```

Number of samples (m) to obtain 10% generalisation error versus data dimension (n)
Winnow Algorithm

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