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clc
clear
close all

filename = 'Data.csv';
delimiter = ',';
startRow = 3;
formatSpec = '%f%f%f%f%f%f%f%[^\n\r]';

fileID = fopen(filename, 'r');

dataArray = textscan(fileID, formatSpec, 'Delimiter', delimiter, 'HeaderLines',
startRow-1, 'ReturnOnError', false);

fclose(fileID);

Sample = dataArray{:, 1};
x1 = dataArray{:, 2};
x2 = dataArray{:, 3};
x3 = dataArray{:, 4};
x4 = dataArray{:, 5};
x5 = dataArray{:, 6};
x6 = dataArray{:, 7};
x7 = dataArray{:, 8};
x8 = dataArray{:, 9};

clearvars filename delimiter startRow formatSpec fileID ans;

Data = [ones(10, 1), x1, x2; ones(10, 1), x3, x4; ones(10, 1), x5, x6; ones(10, 1),
x7, x8'];

tW = [];
for s = 1:6
    hold on;
    switch s
        case 1
            x = [Data(:, 1:10), Data(:, 11:20)];
            str = 'Class 1 vs Class 2';
        case 2
            x = [Data(:, 1:10), Data(:, 21:30)];
            str = 'Class 1 vs Class 3';
        case 3
            x = [Data(:, 1:10), Data(:, 31:40)];
            str = 'Class 1 vs Class 4';
        case 4
            x = [Data(:, 11:20), Data(:, 21:30)];
            str = 'Class 2 vs Class 3';
        case 5
            x = [Data(:, 11:20), Data(:, 31:40)];
            str = 'Class 2 vs Class 4';
        case 6
            x = [Data(:, 21:30), Data(:, 31:40)];
            str = 'Class 3 vs Class 4';
    end

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fig1 = figure(1);
axis square
xlim([-12, 12]);
ylim([-12, 12]);
plot(x(2, 1:10), x(3, 1:10), 'or', 'MarkerFaceColor', 'r');
plot(x(2, 11:20), x(3, 11:20), 'ob', 'MarkerFaceColor', 'b');
title(str);

rnd = @(a, b)(a + (b - a) .* rand());
a = -0.01;
b = +0.01;
K = 2;
d = 2;
N = 20;
c = 2.0;
eta = c;
w = zeros(K, d+1);
delta_w = zeros(K, d+1);
o = zeros(K, 1);
y = zeros(K, 1);
r = zeros(K, N);
Y = zeros(K, N);
r(1, 1:10) = 1;
r(2, 11:20) = 1;

for i = 1:K
    for j = 1:d + 1
        w(i, j) = rnd(a, b);
    end
end

iter = 1;
while true
    wOld = w;
    for i = 1:K
        for j = 1:d + 1
            delta_w(i, j) = 0;
        end
    end
    for t = 1:N
        for i = 1:K
            o(i) = 0;
            for j = 1:d + 1
                o(i) = o(i) + w(i, j) .* x(j, t);
            end
        end
        for i = 1:K
            y(i) = exp(o(i)) / sum(exp(o(:)));
        end
        for i = 1:K
            for j = 1:d + 1
                delta_w(i, j) = delta_w(i, j) + (r(i, t) - y(i)) .* x(j, t);
            end
        end
    end
    Y(:, t) = y(:);
end

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        end
    for i = 1:K
        for j = 1:d + 1
            w(i, j) = w(i, j) + eta .* delta_w(i, j);
        end
    end

    w(1, :) = w(1, :) ./ norm(w(1, 2:3));
    w(2, :) = w(2, :) ./ norm(w(2, 2:3));
    wNew = w;

    if all(ismembertol(wOld, wNew, 0.000001, 'ByRows', true))
        break;
    end
    disp(w);
    iter = iter + 1;
    eta = c / iter;
end

plt0 = ezplot([num2str(w(1, 2)), '* x1 +', num2str(w(1, 3)), '* x2 +',
num2str(w(1, 1))], [-20, 20]);
set(plt0, 'Color', 'magenta', 'LineWidth', 1);
saveas(fig1, ['plot_1_', num2str(s), '.png']);

fig2 = figure(2);
width = 0.4;
b = bar3(Y);
for k = 1:length(b)
    zdata = b(k).ZData;
    b(k).CData = zdata;
    b(k).FaceColor = 'interp';
end
title(str);
saveas(fig2, ['bar3_1_', num2str(s), '.png']);

pause(0.25);
tW = [tW; w(1, :)];

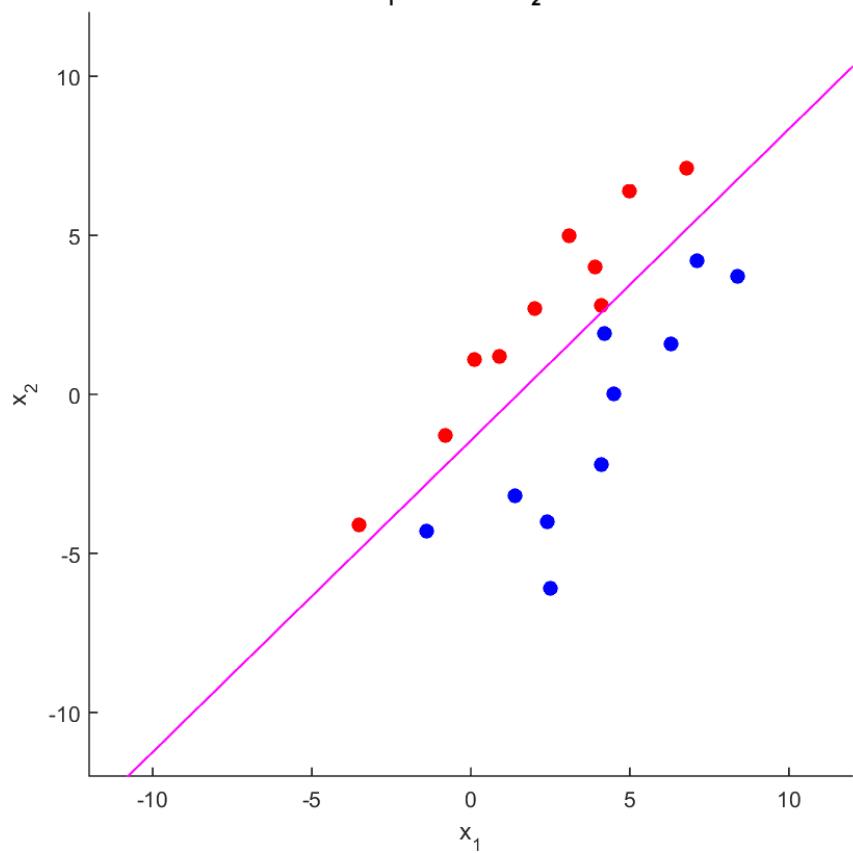
close all;
end

fig3 = figure(3);
hold on;
axis square
xlim([-12, 12]);
ylim([-12, 12]);
plot(Data(2, 1:10), Data(3, 1:10), 'or', 'MarkerFaceColor', 'r');
plot(Data(2, 11:20), Data(3, 11:20), 'og', 'MarkerFaceColor', 'g');
plot(Data(2, 21:30), Data(3, 21:30), 'ob', 'MarkerFaceColor', 'b');
plot(Data(2, 31:40), Data(3, 31:40), 'oc', 'MarkerFaceColor', 'c');
plt1 = ezplot([num2str(tW(1, 2)), '* x1 +', num2str(tW(1, 3)), '* x2 +',
num2str(tW(1, 1))], [-12, 12]);
set(plt1, 'Color', 'magenta', 'LineWidth', 1);
plt2 = ezplot([num2str(tW(2, 2)), '* x1 +', num2str(tW(2, 3)), '* x2 +',
num2str(tW(2, 1))], [-12, 12]);

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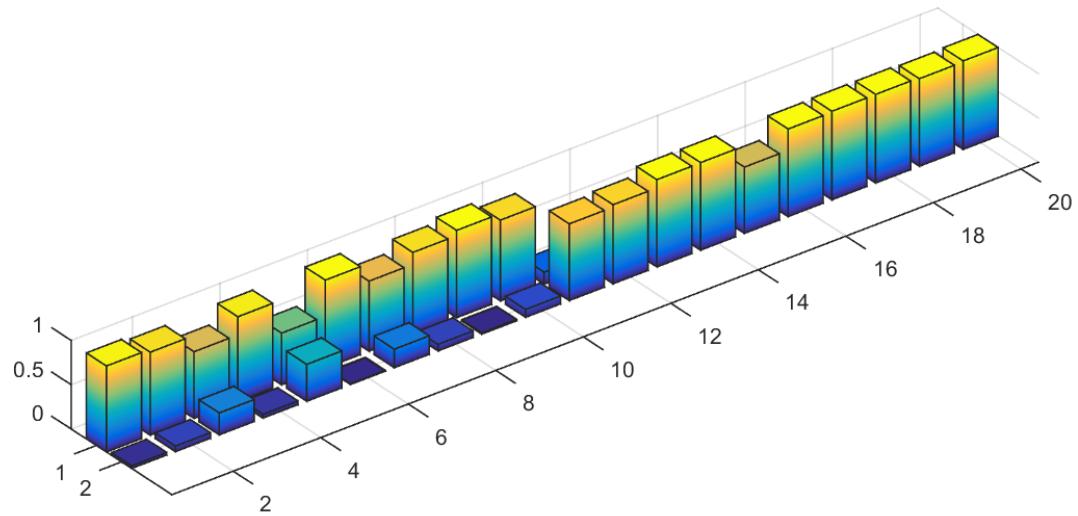
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set(plt2, 'Color', 'magenta', 'LineWidth', 1);
plt3 = ezplot([num2str(tW(3, 2)), '* x1 +', num2str(tW(3, 3)), '* x2 +',
num2str(tW(3, 1))], [-12, 12]);
set(plt3, 'Color', 'magenta', 'LineWidth', 1);
plt4 = ezplot([num2str(tW(4, 2)), '* x1 +', num2str(tW(4, 3)), '* x2 +',
num2str(tW(4, 1))], [-12, 12]);
set(plt4, 'Color', 'magenta', 'LineWidth', 1);
plt5 = ezplot([num2str(tW(5, 2)), '* x1 +', num2str(tW(5, 3)), '* x2 +',
num2str(tW(5, 1))], [-12, 12]);
set(plt5, 'Color', 'magenta', 'LineWidth', 1);
plt6 = ezplot([num2str(tW(6, 2)), '* x1 +', num2str(tW(6, 3)), '* x2 +',
num2str(tW(6, 1))], [-12, 12]);
set(plt6, 'Color', 'magenta', 'LineWidth', 1);
title([]);
saveas(fig3, 'plot_3.png');
```

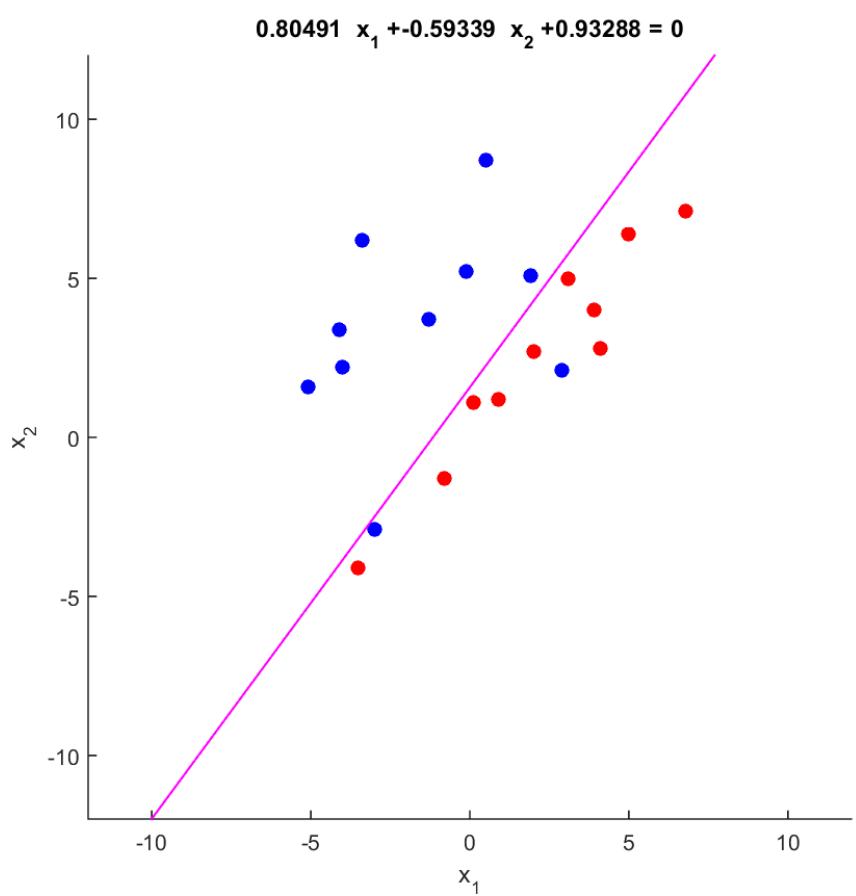
$$-0.69967 x_1 + 0.71447 x_2 + 1.0373 = 0$$



o

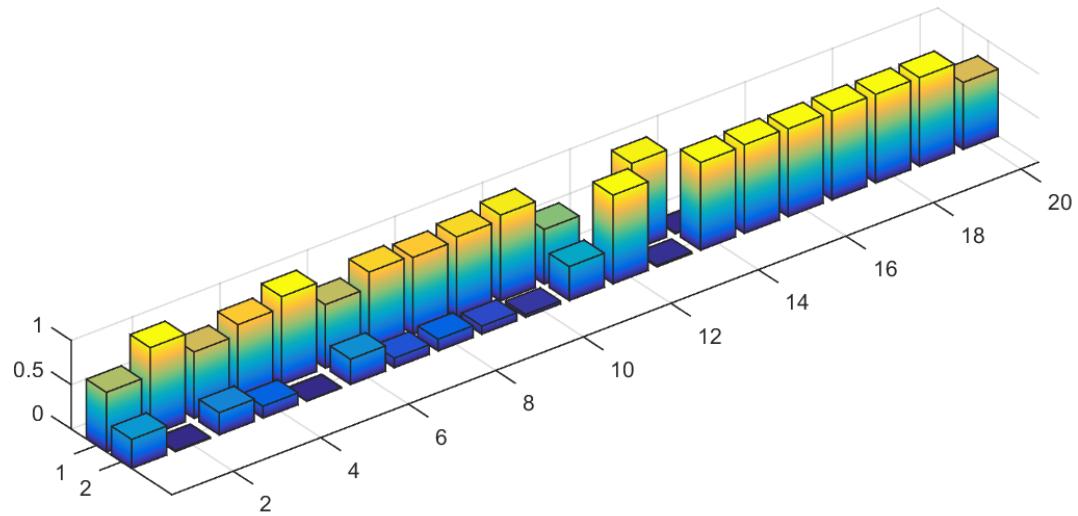
Class 1 vs Class 2





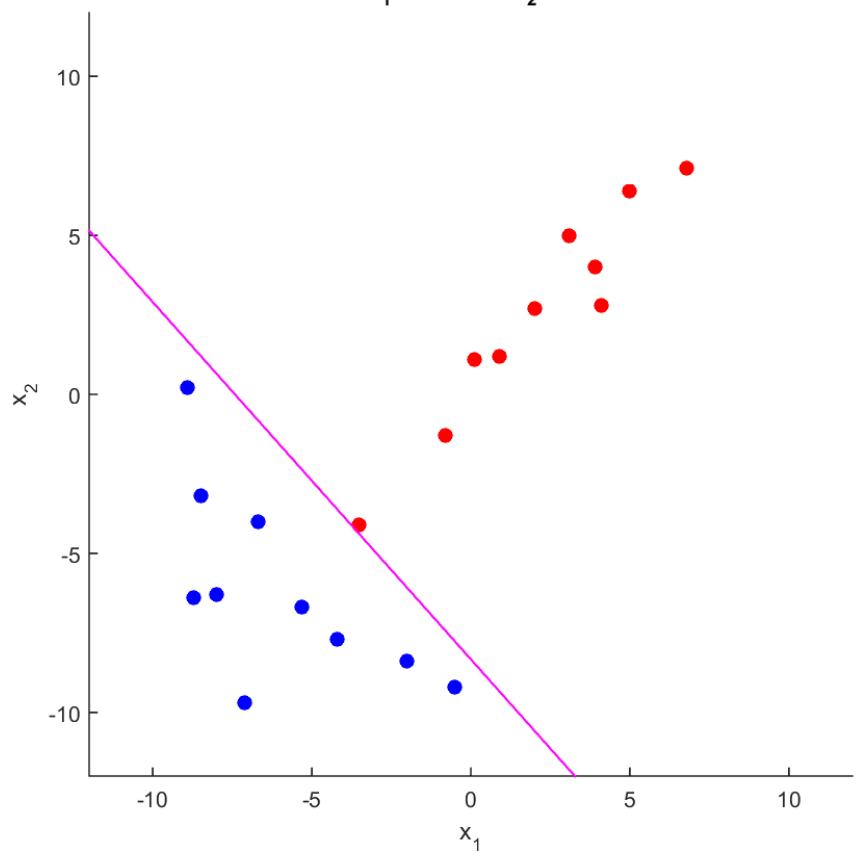
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Class 1 vs Class 3

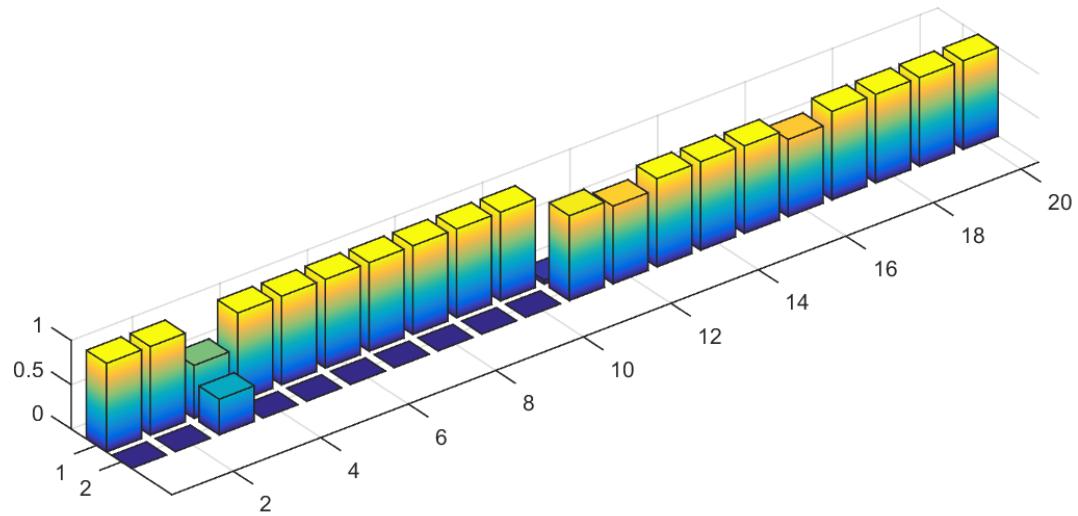


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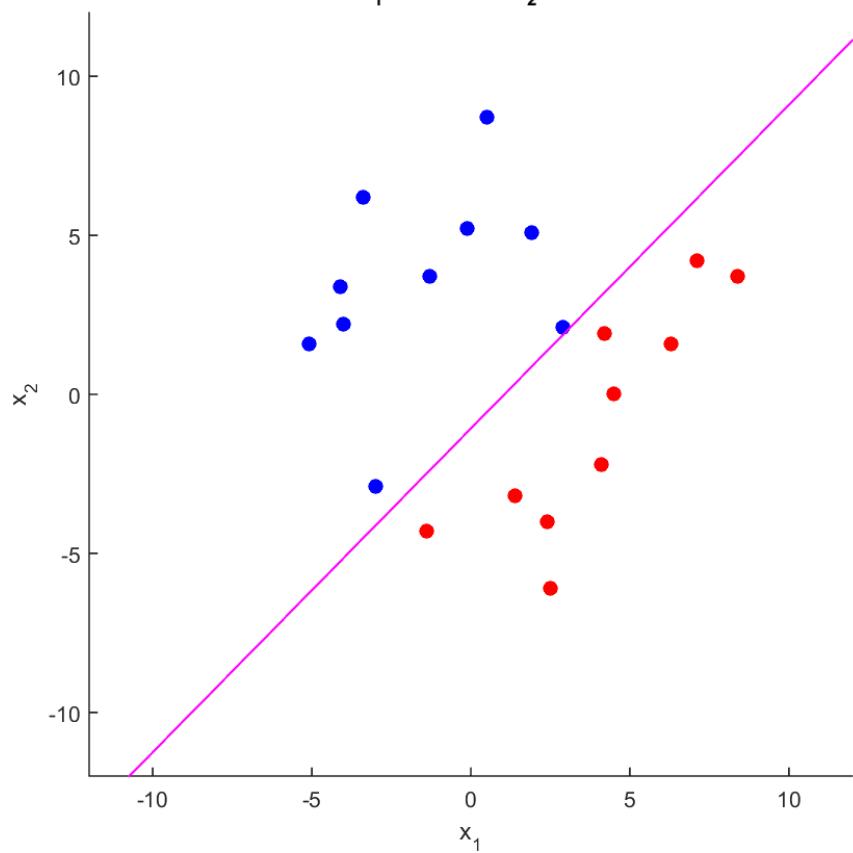
$$0.74682 x_1 + 0.66503 x_2 + 5.5395 = 0$$



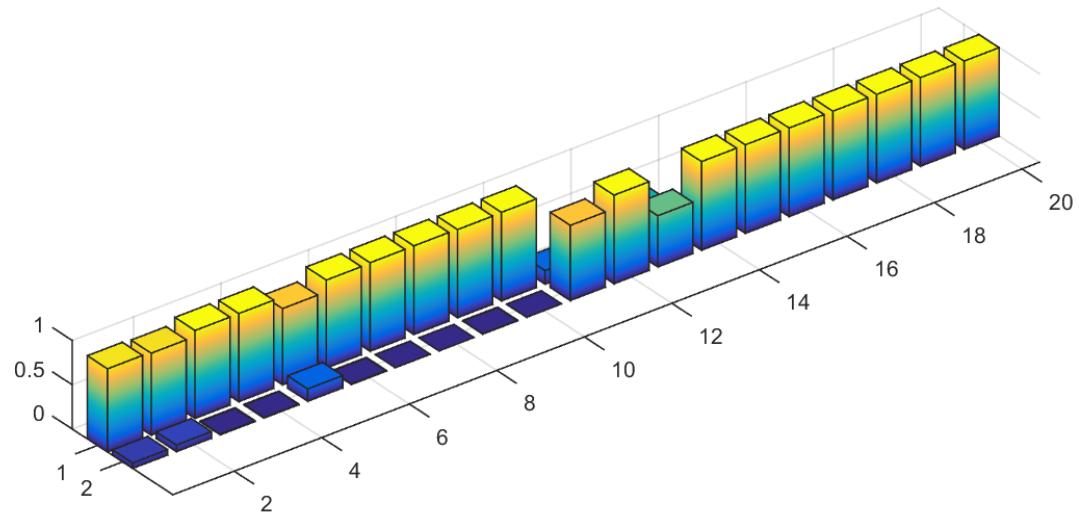
Class 1 vs Class 4



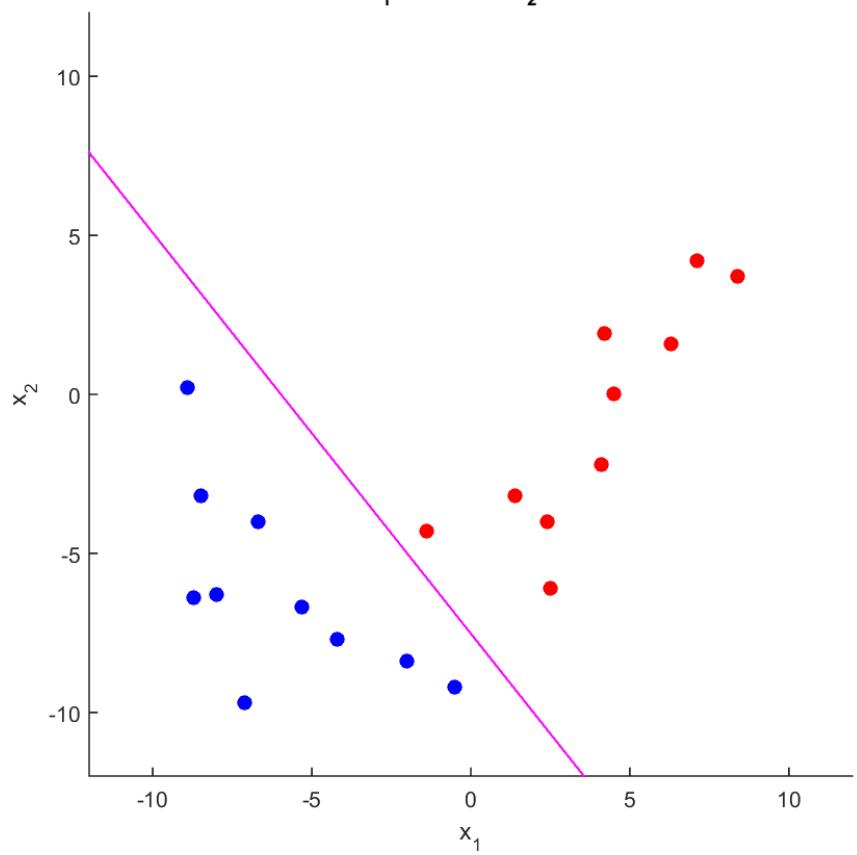
$$0.71323 x_1 + -0.70093 x_2 + -0.7531 = 0$$



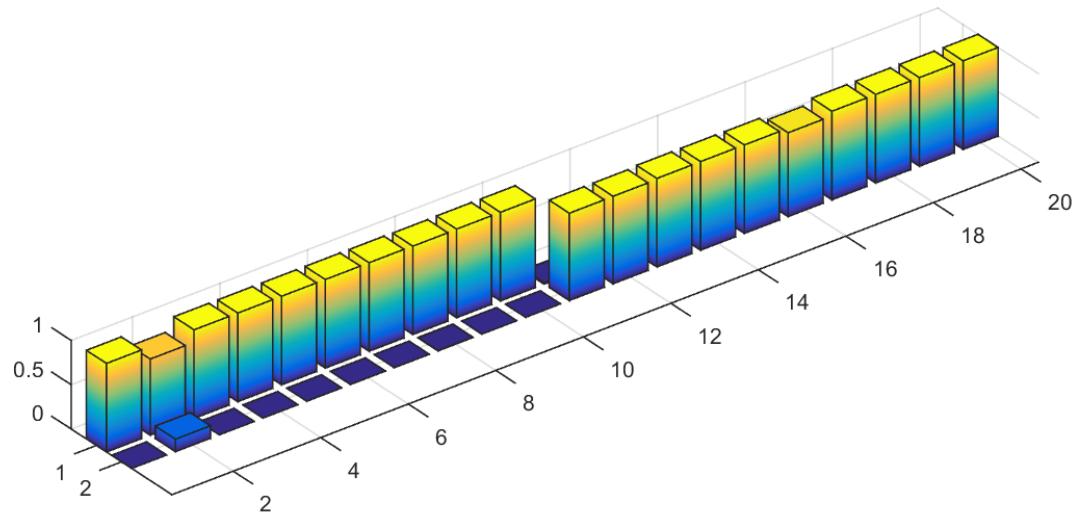
Class 2 vs Class 3



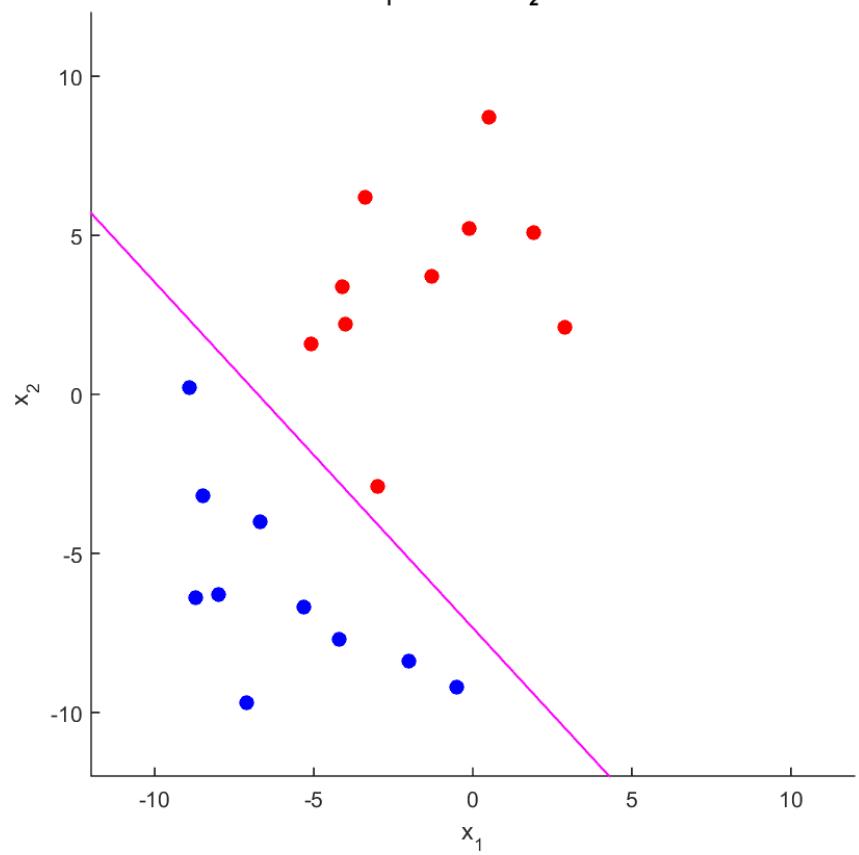
$$0.78329 x_1 + 0.62165 x_2 + 4.6757 = 0$$



Class 2 vs Class 4



$$0.73586 x_1 + 0.67713 x_2 + 4.9728 = 0$$



Class 3 vs Class 4

