Contents

```
clc; clear all; close all;
```

Load music and compute spectrogram

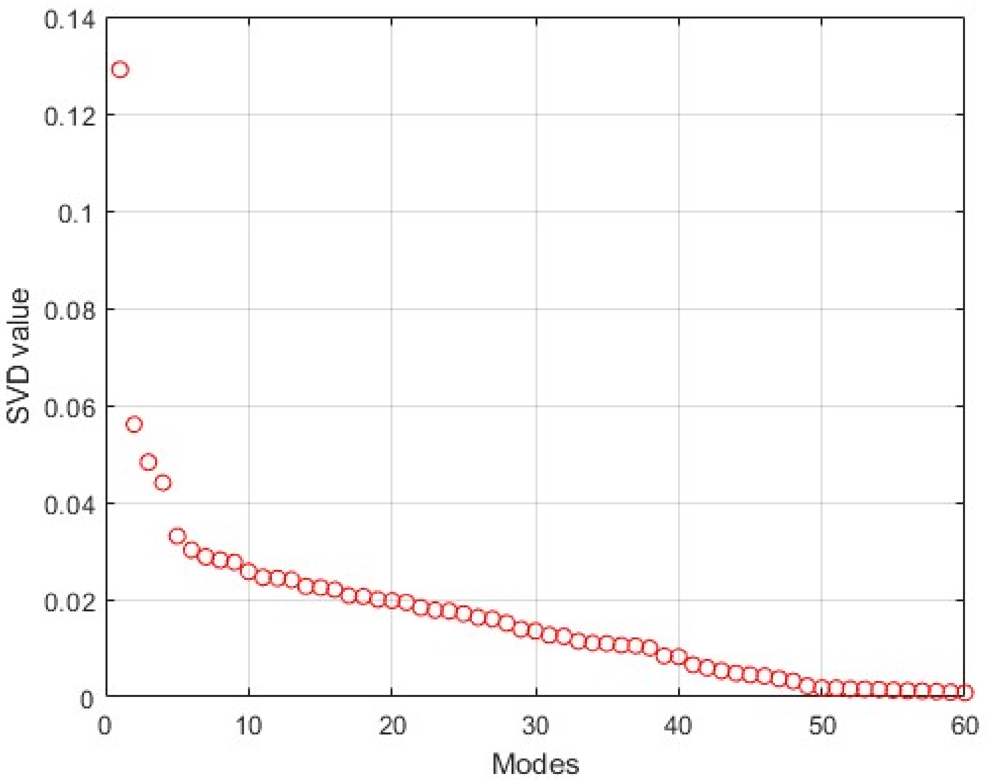
```
pathTrain = 'songs\test1\train\*.mp3';
nClips = 10;
clipLength = 5;
[Train, fNameTrain] = spectro(pathTrain, nClips, clipLength);
```

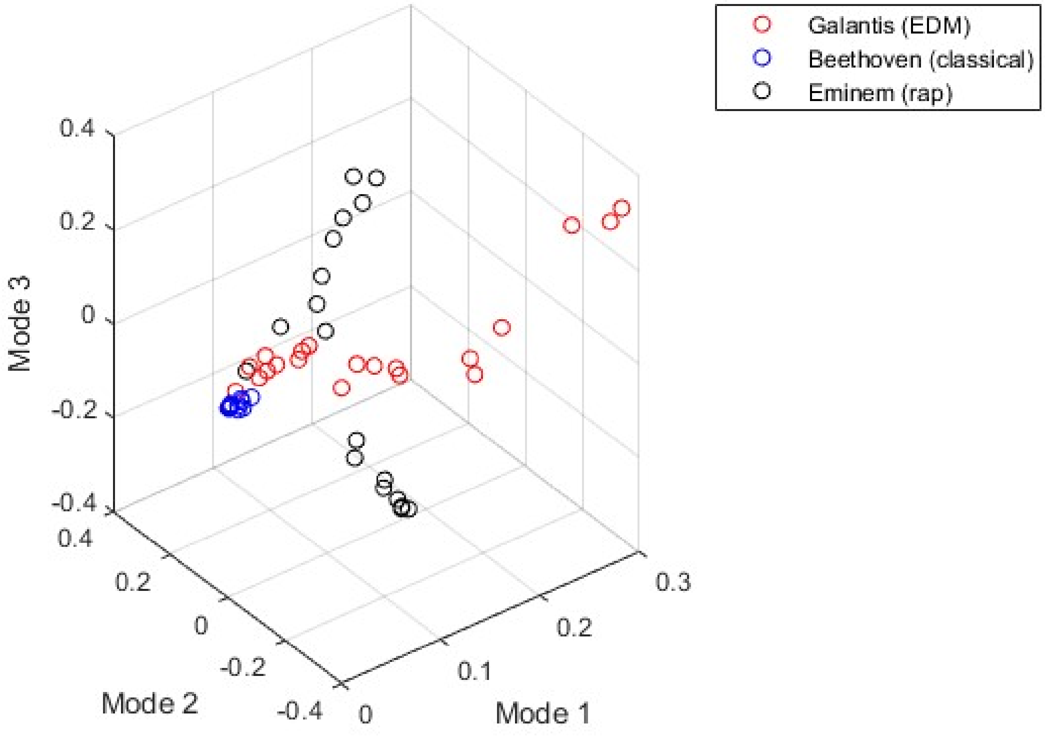
Perform SVD on the spectrogram

```
[U, S, V] = svd(Train, 'econ');
diagS = diag(S)/sum(diag(S));

figure(1)
plot(diagS, 'ro');
grid on;
xlabel('Modes');
ylabel('SVD value');

figure(2)
plot3(V(1:(2*nClips), 1), V(1:(2*nClips), 2), V(1:(2*nClips), 3), 'ro');
grid on;
hold on;
plot3(V((2*nClips + 1):(4*nClips), 1), V((2*nClips + 1):(4*nClips), 2), ...
    V((2*nClips + 1):(4*nClips), 3), 'bo');
plot3(V((4*nClips + 1):(6*nClips), 1), V((4*nClips + 1):(6*nClips), 2), ...
    V((4*nClips + 1):(6*nClips), 3), 'ko');
legend('Galantis (EDM)', 'Beethoven (classical)', 'Eminem (rap)')
xlabel('Mode 1');
ylabel('Mode 2');
zlabel('Mode 3');
```


0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
SVD value
0
10
20
30
40
50
60
Modes


Galantis (EDM)
Beethoven (classical)
Eminem (rap)
0.4
0.2
0
-0.2
-0.4
Mode 3
0.4
0.2
0
-0.2
-0.4
Mode 2
0
0.1
0.2
0.3
Mode 1

Load test

```
pathTest = 'songs\test1\test\*.mp3';
[Test, fNameTest] = spectro(pathTest, 2*nClips, clipLength);
```

Build Classifier

```
feature = 3; % 3 = 0.80
[U1, S1, V1, threshold12, threshold23, w, sort1, sort2, sort3] ...
    = artist_trainer(Train, nClips, feature);
pval = w'*(U1'*Test);

resultL = length(pval);
result = strings(1, resultL);
for i = 1:length(pval)
    pval1 = pval(i);
    if pval1 >= threshold23
        result(i) = "C";
    elseif pval1 >= threshold12
        result(i) = "E";
    else
        result(i) = "P";
    end
end

answer = strings(1, resultL);
for i = 1:length(result)
    if i <= resultL/3
        answer(i) = "E";
    elseif i <= resultL*2/3
        answer(i) = "C";
    else
        answer(i) = "P";
    end
end
compare = result == answer;
disp(compare);
accuracy = length(find(compare == 1))/length(result);
disp(accuracy)



function [Data, fName] = spectro(path, nClips, clipLength)
    folder = dir(path);
    nSongs = length(folder);
    Data = [];
    fName = [];
    for i = 1:nSongs
        fname = folder(i).name;
        fName = [fName, convertCharsToStrings(fname)];
        [y, Fs] = audioread([path(1:end -5), fname]);
        y = (y(:, 1) + y(:, 2))/2;
        s = y';
        t = (1:length(s))/Fs;
        lengthSong = t(end);
        totalClips = lengthSong/clipLength;
        clipSpace = totalClips/nClips;
        tempData = [];
        for j = 1:clipSpace:totalClips
            sStart = floor((j - 1)*clipLength);
            if j == 1
                sStart = 1;
            end
            sEnd = sStart + clipLength;
            clip = s(1, sStart*Fs : sEnd*Fs);
            clipSpec = abs(spectrogram(clip));
            clipSpec = reshape(clipSpec, ...
                size(clipSpec, 1)*size(clipSpec, 2), 1);
            tempData = [tempData, clipSpec];
        end
        Data = [Data, tempData - mean(tempData(:))];
    end
end


function [U, S, V, threshold12, threshold23, w, sort1, sort2, ...
    sort3] = artist_trainer(Data, nSample, feature)

    [U, S, V] = svd(Data, 'econ');

    n = 2*nSample;

    Artist = S*V';
    U = U(:, 1:feature);
    A1 = Artist(1:feature, 1:n);
    A2 = Artist(1:feature, (n + 1):(n + n));
    A3 = Artist(1:feature, (n + n + 1):(n + n + n));

    m1 = mean(A1, 2);
    m2 = mean(A2, 2);
    m3 = mean(A3, 2);
    mOverall = (m1 + m2 + m3)./3;

    Sw = 0;
    for i = 1:n
        Sw = Sw + (A1(:, i) - m1)*(A1(:, i) - m1)';
    end
    for i = 1:n
        Sw = Sw + (A2(:, i) - m2)*(A2(:, i) - m2)';
    end
    for i = 1:n
        Sw = Sw + (A3(:, i) - m3)*(A3(:, i) - m3)';
    end
    SB = ((m1 - mOverall)*(m1 - mOverall)' + (m2 - mOverall)*...
        (m2 - mOverall)' + (m3 - mOverall)*(m3 - mOverall)')/3;

    [V2, D] = eig(SB, Sw);
    [~, ind] = max(abs(diag(D)));
    w = V2(:,ind);
    w = w/norm(w, 2);

    v1 = w'*A1;
    v2 = w'*A2;
    v3 = w'*A3;

    vM1 = mean(v1);
    vM2 = mean(v2);
    vM3 = mean(v3);

    sort1 = sort(v1);
    sort2 = sort(v2);
    sort3 = sort(v3);

   % v3 < threshold1 < v1 < threshold2 < v2

    bot = length(sort3);
    top = 1;
    while sort3(bot) > sort1(top)
        bot = bot - 1;
        top = top + 1;
    end
    threshold12 = (sort3(bot) + sort1(top))/2;

    bot = length(sort1);
    top = 1;
    while sort1(bot) > sort2(top)
        bot = bot - 1;
        top = top + 1;
    end
    threshold23 = (sort1(bot) + sort2(top))/2;
end
```

```
  Columns 1 through 19

   1   1   1   1   1   1   1   0   0   0   0   0   0   1   1   1   0   0   0

  Columns 20 through 38

   0   1   1   1   1   1   1   1   1   1   1   1   1   1   0   1   1   1   1

  Columns 39 through 57

   1   1   0   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
  Columns 58 through 60

     1     1     1

    0.8000
```

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Contents

```
clc; clear all; close all;
```

Load music and compute spectrogram

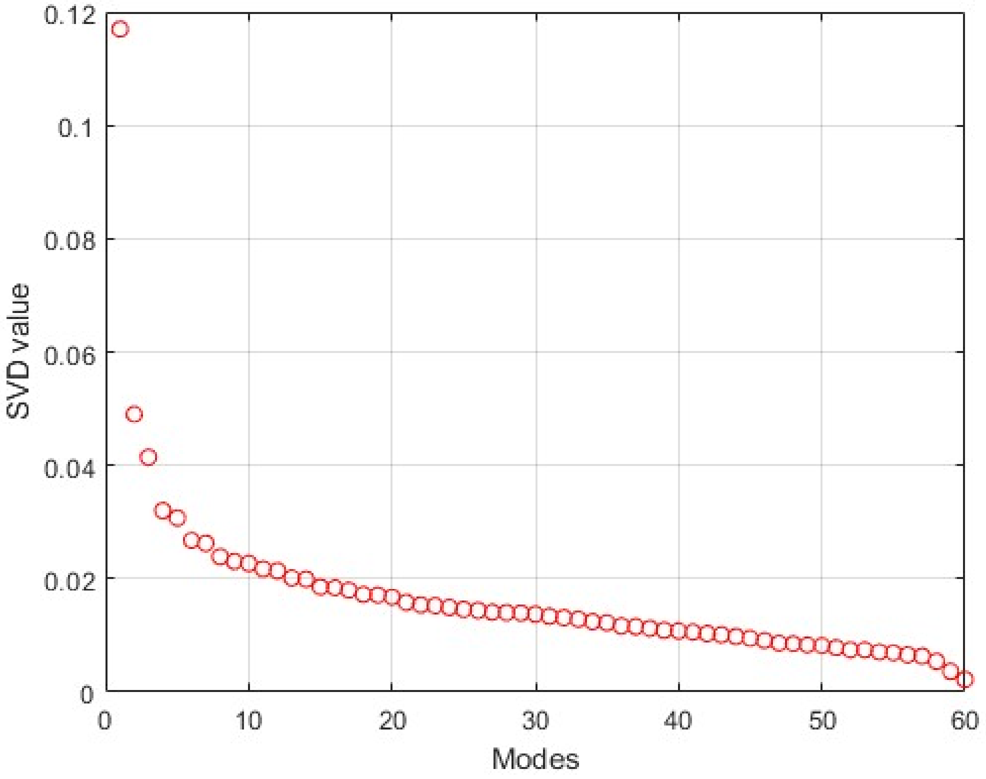
```
pathTrain = 'songs\test2\train\*.mp3';
nClips = 10;
clipLength = 5;
[Train, fNameTrain] = spectro(pathTrain, nClips, clipLength);
```

Perform SVD on the spectrogram

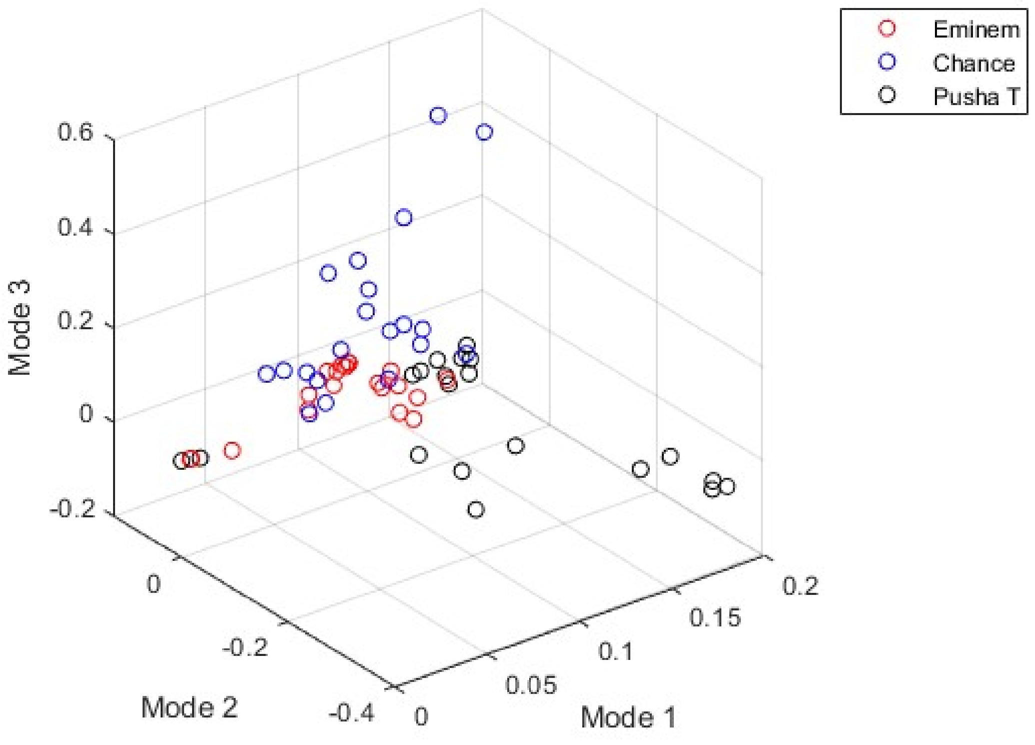
```
[U, S, V] = svd(Train, 'econ');
diagS = diag(S)/sum(diag(S));

figure(1)
plot(diagS, 'ro');
grid on;
xlabel('Modes');
ylabel('SVD value');

figure(2)
plot3(V(1:(2*nClips), 1), V(1:(2*nClips), 2), V(1:(2*nClips), 3), 'ro');
grid on;
hold on;
plot3(V((2*nClip + 1):(4*nClips), 1), V((2*nClip + 1):(4*nClips), 2), ...
    V((2*nClip + 1):(4*nClips), 3), 'bo');
plot3(V((4*nClip + 1):(6*nClips), 1), V((4*nClip + 1):(6*nClips), 2), ...
    V((4*nClip + 1):(6*nClips), 3), 'ko');
legend('Eminem', 'Chance', 'Pusha T')
xlabel('Mode 1');
ylabel('Mode 2');
zlabel('Mode 3');
```



SVD value
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
Modes



Eminem
Chance
Pusha T
Mode 3
0.6
0.4
0.2
0
-0.2
Mode 2
0
-0.2
-0.4
Mode 1
0
0.05
0.1
0.15
0.2

Load test

```
pathTest = 'songs\test2\test\*.mp3';
[Test, fNameTest] = spectro(pathTest, nClips, clipLength);
```

Build Classifier

```
feature = 8; % 8
[U1, S1, V1, threshold12, threshold23, w, sort1, sort2, sort3] ...
    = artist_trainer(Train, nClips, feature);

pval = w'*(U1'*Test);

resultL = length(pval);
result = strings(1, resultL);
for i = 1:length(pval)
    pval1 = pval(i);
    if pval1 >= threshold23
        result(i) = "C";
    elseif pval1 >= threshold12
        result(i) = "E";
    else
        result(i) = "P";
    end
end

answer = strings(1, resultL);
for i = 1:length(result)
    if i <= resultL/3
        answer(i) = "E";
    elseif i <= resultL*2/3
        answer(i) = "C";
    else
        answer(i) = "P";
    end
end
compare = result == answer;
disp(compare);
accuracy = length(find(compare == 1))/length(result);
disp(accuracy)

function [Data, fName] = spectro(path, nClips, clipLength)
    folder = dir(path);
    nSongs = length(folder);
    Data = [];
    fName = [];
    for i = 1:nSongs
        fname = folder(i).name;
        fName = [fName, convertCharsToStrings(fname)];
        [y, Fs] = audioread([path(1:end -5), fname]);
        y = (y(:, 1) + y(:, 2))/2;
        s = y';
        t = (1:length(s))/Fs;
        lengthSong = t(end);
        totalClips = lengthSong/clipLength;
        clipSpace = totalClips/nClips;
        tempData = [];
        for j = 1:clipSpace:totalClips
            sStart = floor((j - 1)*clipLength);
            if j == 1
                sStart = 1;
            end
            sEnd = sStart + clipLength;
            clip = s(1, sStart*Fs : sEnd*Fs);
            clipSpec = abs(spectrogram(clip));
            clipSpec = reshape(clipSpec, ...
                size(clipSpec, 1)*size(clipSpec, 2), 1);
            tempData = [tempData, clipSpec];
        end
        Data = [Data, tempData - mean(tempData(:))];
    end
end

function [U, S, V, threshold12, threshold23, w, sort1, sort2, ...
    sort3] = artist_trainer(Data, nSample, feature)

    [U, S, V] = svd(Data, 'econ');

    n = 2*nSample;

    Artist = S*V';
    U = U(:, 1:feature);
    A1 = Artist(1:feature, 1:n);
    A2 = Artist(1:feature, (n + 1):(n + n));
    A3 = Artist(1:feature, (n + n + 1):(n + n + n));

    m1 = mean(A1, 2);
    m2 = mean(A2, 2);
    m3 = mean(A3, 2);
    mOverall = (m1 + m2 + m3)./3;

    Sw = 0;
    for i = 1:n
        Sw = Sw + (A1(:, i) - m1)*(A1(:, i) - m1)';
    end
    for i = 1:n
        Sw = Sw + (A2(:, i) - m2)*(A2(:, i) - m2)';
    end
    for i = 1:n
        Sw = Sw + (A3(:, i) - m3)*(A3(:, i) - m3)';
    end

    SB = ((m1 - mOverall)*(m1 - mOverall)' + (m2 - mOverall)*...
        (m2 - mOverall)' + (m3 - mOverall)*(m3 - mOverall)')/3;
    [V2, D] = eig(SB, Sw);
    [~, ind] = max(abs(diag(D)));
    w = V2(:,ind);
    w = w/norm(w, 2);

    v1 = w'*A1;
    v2 = w'*A2;
    v3 = w'*A3;

    vM1 = mean(v1);
    vM2 = mean(v2);
    vM3 = mean(v3);

    sort1 = sort(v1);
    sort2 = sort(v2);
    sort3 = sort(v3);

   % v3 < threshold1 < v1 < threshold2 < v2

    bot = length(sort3);
    top = 1;
    while sort3(bot) > sort1(top)
        bot = bot - 1;
        top = top + 1;
    end
    threshold12 = (sort3(bot) + sort1(top))/2;

    bot = length(sort1);
    top = 1;
    while sort1(bot) > sort2(top)
        bot = bot - 1;
        top = top + 1;
    end
    threshold23 = (sort1(bot) + sort2(top))/2;
end
```

```
  Columns 1 through 19

   1   1   1   1   1   1   1   1   1   1   0   0   0   0   0   1   0   0   0

  Columns 20 through 30

   0   0   0   0   1   0   0   1   0   0   0

    0.4333
```

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Contents

```
clc; clear all; close all;
```

Load music and compute spectrogram

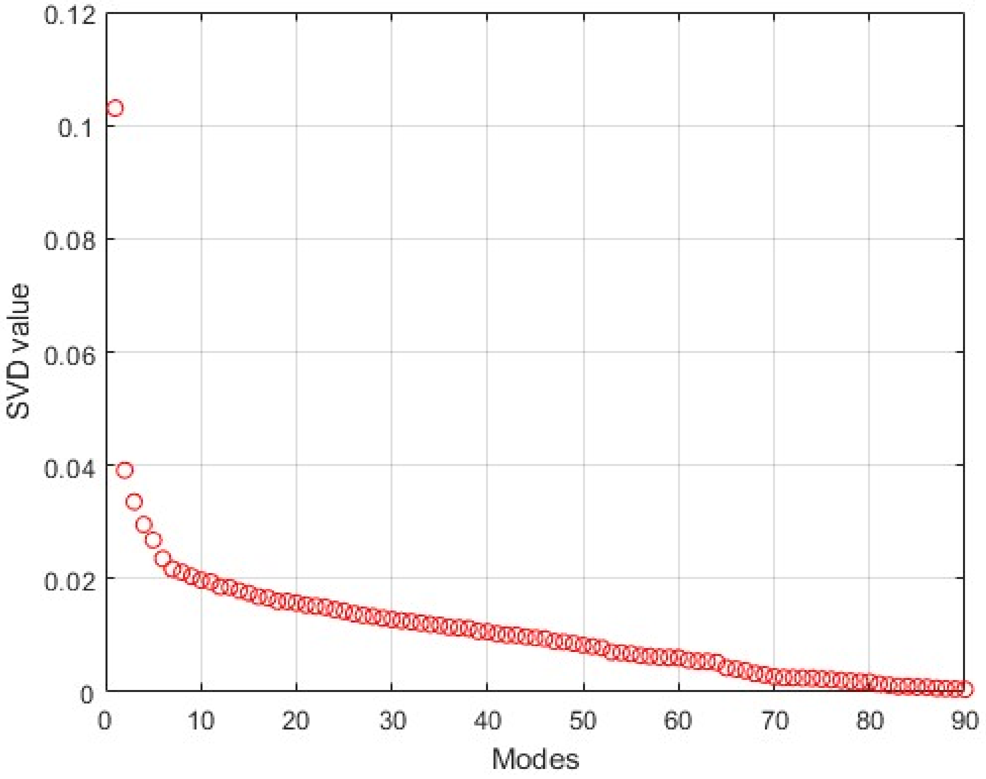
```
pathTrain = 'songs\test3\train\*.mp3';
nClips = 10;
clipLength = 5;
[Train, fNameTrain] = spectro(pathTrain, nClips, clipLength);
```

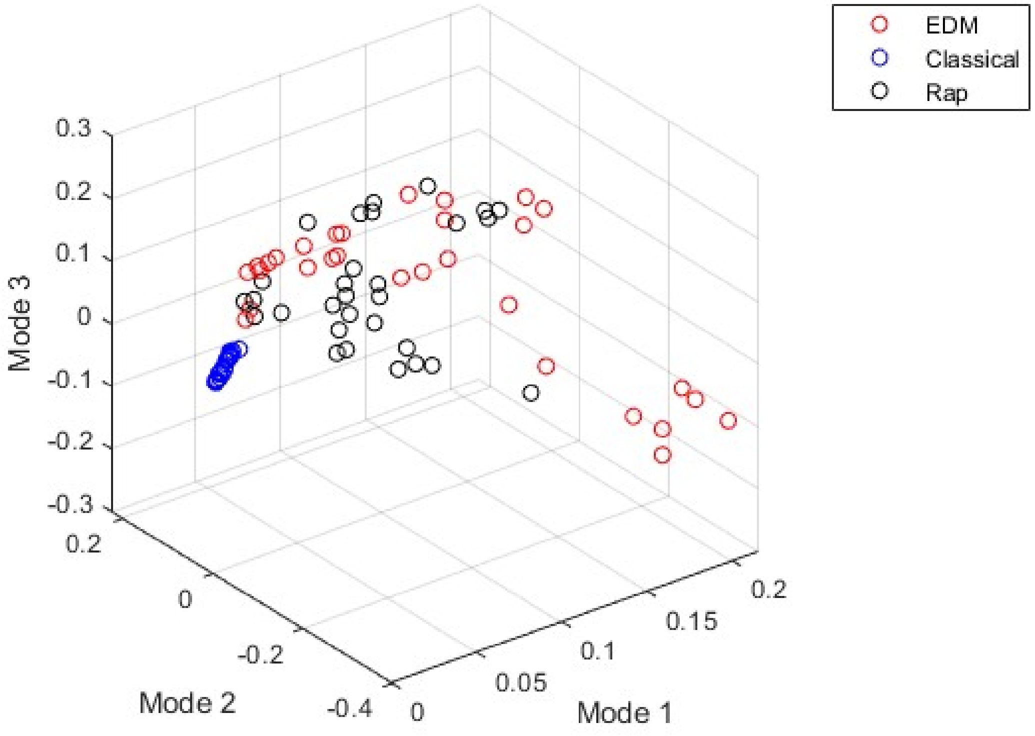
Perform SVD on the spectrogram

```
[U, S, V] = svd(Train, 'econ');
diagS = diag(S)/sum(diag(S));

figure(1)
plot(diagS, 'ro');
grid on;
xlabel('Modes');
ylabel('SVD value');

figure(2)
plot3(V(1:(3*nClips), 1), V(1:(3*nClips), 2), V(1:(3*nClips), 3), 'ro');
grid on;
hold on;
plot3(V((3*nClips + 1):(6*nClips), 1), V((3*nClips + 1):(6*nClips), 2), ...
    V((3*nClips + 1):(6*nClips), 3), 'bo');
plot3(V((6*nClips + 1):(9*nClips), 1), V((6*nClips + 1):(9*nClips), 2), ...
    V((6*nClips + 1):(9*nClips), 3), 'ko');
legend('EDM', 'Classical', 'Rap')
xlabel('Mode 1');
ylabel('Mode 2');
zlabel('Mode 3');
```


0.12
0.1
0.08
0.06
0.04
0.02
0
SVD value
0
10
20
30
40
50
60
70
80
90
Modes


EDM
Classical
Rap
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
Mode 3
0.2
0
-0.2
-0.4
Mode 2
0
0.05
0.1
0.15
0.2
Mode 1

Load test

```
pathTest = 'songs\test3\test\*.mp3';
[Test, fNameTest] = spectro(pathTest, 10, clipLength);
```

Build Classifier

```
feature = 3; % 8
[U1, S1, V1, threshold12, threshold23, w, sort1, sort2, sort3] ...
    = genre_trainer(Train, nClips, feature);

pval = w'*(U1'*Test);

resultL = length(pval);
result = strings(1, resultL);
for i = 1:length(pval)
    pval1 = pval(i);

    if pval1 >= threshold23
        result(i) = "EDM";
    elseif pval1 >= threshold12
        result(i) = "RAP";
    else
        result(i) = "CLASS";
    end
end

answer = strings(1, resultL);
for i = 1:length(result)
    if i <= resultL/3
        answer(i) = "EDM";
    elseif i <= resultL*2/3
        answer(i) = "CLASS";
    else
        answer(i) = "RAP";
    end
end
compare = result == answer;
disp(compare);
accuracy = length(find(compare == 1))/length(result);
disp(accuracy)

function [Data, fName] = spectro(path, nClips, clipLength)
    folder = dir(path);
    nSongs = length(folder);
    Data = [];
    fName = [];
    for i = 1:nSongs
        fname = folder(i).name;
        fName = [fName, convertCharsToStrings(fname)];
        [y, Fs] = audioread([path(1:end -5), fname]);
        y = (y(:, 1) + y(:, 2))/2;
        s = y';
        t = (1:length(s))/Fs;
        lengthSong = t(end);
        totalClips = lengthSong/clipLength;
        clipSpace = totalClips/nClips;
        tempData = [];
        for j = 1:clipSpace:totalClips
            sStart = floor((j - 1)*clipLength);
            if j == 1
                sStart = 1;
            end
            sEnd = sStart + clipLength;
            clip = s(1, sStart*Fs : sEnd*Fs);
            clipSpec = abs(spectrogram(clip));
            clipSpec = reshape(clipSpec, ...
                size(clipSpec, 1)*size(clipSpec, 2), 1);
            tempData = [tempData, clipSpec];
        end
        Data = [Data, tempData - mean(tempData(:))];
    end
end

function [U, S, V, threshold12, threshold23, w, sort1, sort2, ...
    sort3] = genre_trainer(Data, nSample, feature)

    [U, S, V] = svd(Data, 'econ');

    n = 3*nSample;

    Genre = S*V';
    U = U(:, 1:feature);
    G1 = Genre(1:feature, 1:n);
    G2 = Genre(1:feature, (n + 1):(n + n));
    G3 = Genre(1:feature, (n + n + 1):(n + n + n));

    m1 = mean(G1, 2);
    m2 = mean(G2, 2);
    m3 = mean(G3, 2);
    mOverall = (m1 + m2 + m3)./3;

    Sw = 0;
    for i = 1:n
        Sw = Sw + (G1(:, i) - m1)*(G1(:, i) - m1)';
    end
    for i = 1:n
        Sw = Sw + (G2(:, i) - m2)*(G2(:, i) - m2)';
    end
    for i = 1:n
        Sw = Sw + (G3(:, i) - m3)*(G3(:, i) - m3)';
    end

    SB = ((m1 - mOverall)*(m1 - mOverall)' + (m2 - mOverall)*...
        (m2 - mOverall)' + (m3 - mOverall)*(m3 - mOverall)')/3;

    [V2, D] = eig(SB, Sw);
    [~, ind] = max(abs(diag(D)));
    w = V2(:,ind);
    w = w/norm(w, 2);

    v1 = w'*G1;
    v2 = w'*G2;
    v3 = w'*G3;

    vM1 = mean(v1);
    vM2 = mean(v2);
    vM3 = mean(v3);

    sort1 = sort(v1);
    sort2 = sort(v2);
    sort3 = sort(v3);

    % v2 < threshold1 < v3 < threshold2 < v1

    bot = length(sort2);
    top = 1;
    while sort2(bot) > sort3(top)
        bot = bot - 1;
        top = top + 1;
    end
    threshold12 = (sort2(bot) + sort3(top))/2;

    bot = length(sort3);
    top = 1;
    while sort3(bot) > sort1(top)
        bot = bot - 1;
        top = top + 1;
    end
    threshold23 = (sort3(bot) + sort1(top))/2;
end
```

```
Columns 1 through 19

 0   0   0   0   0   1   1   0   0   1   1   1   1   1   1   1   1   1   1

Columns 20 through 30

 1   1   1   1   0   1   1   1   1   1   0

  0.7000
```

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