

MACHINE LEARNING FOR SIGNAL
PROCESSING

HOMEWORK 1

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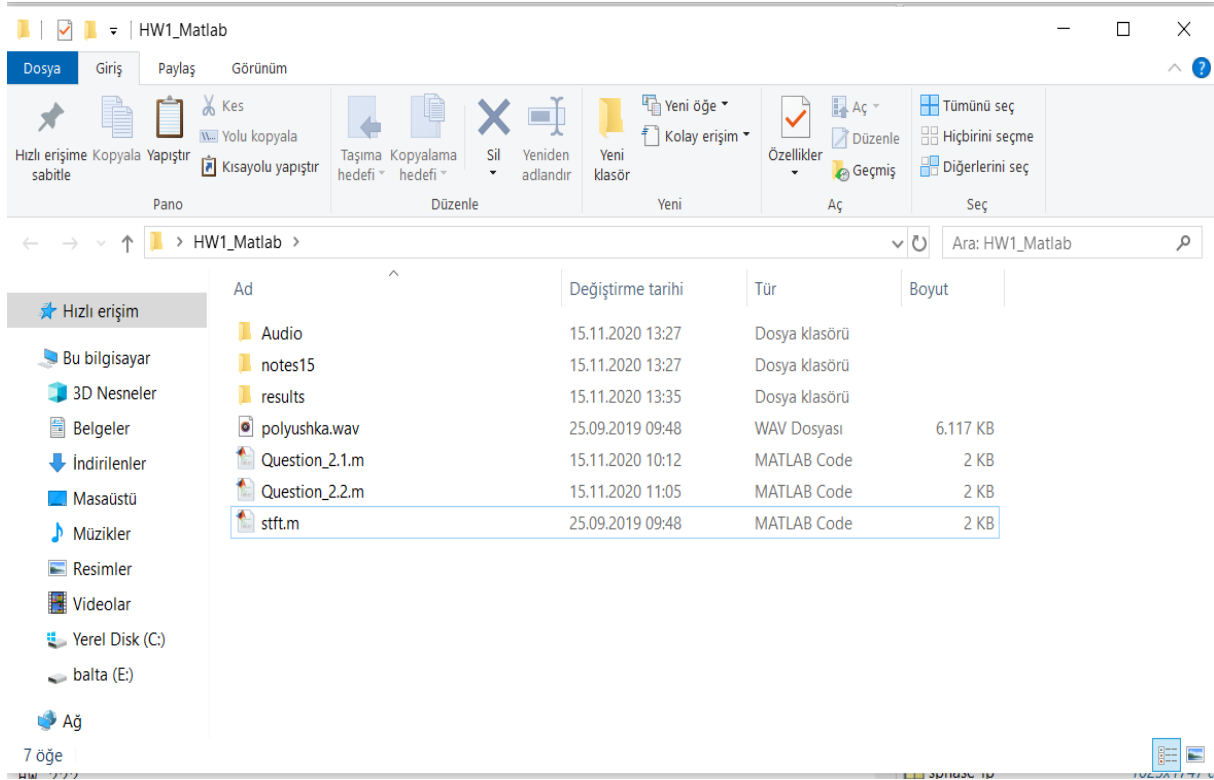
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Question 2.1

We created the matlab file called ‘Question_2.1.m’. To achieve the answer of the question 2.1, we applied all steps in one matlab file.

Firstly, when download the HW1_Matlab file, you must see a file shown below.



If you run the Question_2.1.m and Question_2.2.m files, the answered music files for Q1 and Q2 will be saved to the file called ‘results’.

We read the notes in the note folder and get the spectrum. We applied the same steps for “polyushka.wav” file. After that, we did matrix operations to obtain the W matrix. To obtain inverse matrix of the notes matrix, we used pinv() function. We take real values in W matrix. Then, we created new music and saved to results file.

```

1 % We read the notes in note folder and get the spectrum.
2 clear all;
3
4 notesfolder = 'notes15';
5 listname = dir([notesfolder filesep '*.wav']);
6 notes = [];
7
8 for k = 1:length(listname)
9     [s, fs] = audioread([notesfolder filesep listname(k).name]);
10    s = s(:, 1);
11    s = resample(s, 16000, fs);
12    spectrum = stft(s', 2048, 256, 0, hann(2048));
13    %Find the central frame
14    middle = ceil(size(spectrum, 2) / 2);
15    note = abs(spectrum(:, middle));
16    %Clean up everything more than 40 db below the peak
17    note(find(note < max(note(:))/100)) = 0 ;
18    note = note/norm(note);
19    %normalize the note to unit length
20    notes = [notes, note];
21 end
22
23 % We read the 'polyushka'. We use stft function for spectrum.
24 [m, fs]=audioread("polyushka.wav");
25 m = resample(m, 16000, fs);

```

```

26 m = resample(m, 16000, fs);
27 spectrum_m = stft(m', 2048, 256, 0, hann(2048));
28 note_m=spectrum_m;
29 sphase=spectrum_m./(abs(spectrum_m)+eps);
30 % Matrix calculations
31 % NW = M --> W = W^-1 * M
32 % We find the inverse of N as using the 'pinv' function
33 % We did multiplication and reconstructing signal process
34 x = pinv(notes);
35 W = x * note_m;
36 W(find(W<0)) = 0 ;
37 W = real(W);
38 M=notes * W;
39
40 reconstructedsignal = stft(M.*sphase,2048,256,0,hann(2048));
41 reconstructedsignal = 100 * resample(reconstructedsignal, fs, 16000); % 40 db
42
43 filename = 'results/reconstructed_polyushka.wav';
44 audiowrite(filename,reconstructedsignal, fs);
45

```

Question 2.2

We solved matrix equations to obtain 'littlestar_guitar.wav' file. You can see the matrix calculation steps below.

Handwritten matrix equations on a piece of paper:

$$\begin{aligned}L_p &= N_p \cdot W_L \\S_g &= N_g \cdot W_s \\S_p &= N_p \cdot W_s \\ \hline \star L_g &= N_g \cdot W_L\end{aligned}$$
$$\begin{aligned}N_g &= S_g W_s^{-1} \\W_L &= N_p^{-1} \cdot L_p\end{aligned}$$
$$L_g = S_g W_s^{-1} N_p^{-1} \cdot L_p$$

$$L_g = S_g \cdot S_p^{-1} \cdot L_p$$

We solved the equation with matlab and recovered the signal. Then, we created guitar version of littlestar song.

MATLAB R2018a - academic use

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Insert Comment Indent Breakpoints Run Run and Advance Run Section Run and Time

Current Folder: C:\Users\ilker\OneDrive\Masaüstü\HW1_Matlab

Editor: C:\Users\ilker\OneDrive\Masaüstü\HW1_Matlab\Question_2.2.m

```

1 %% Question 2.2
2 clear all;
3
4 notesfolder = 'Audio';
5 listname = dir([notesfolder filesep '*.aif']);
6
7 %% We read littlestar_piano.aif file
8 [l, fs_lp] = audioread([notesfolder filesep listname(1).name]);
9 l = l(:, 1);
10 l = resample(l, 16000, fs_lp);
11 spectrum_lp = stft(l, 2048, 256, 0, hann(2048));
12 s_lp=spectrum_lp;
13
14 s_lp(find(s_lp<max(s_lp(:))/100)) = 0 ;
15 s_lp = s_lp/norm(s_lp);
16
17 sphase_lp=spectrum_lp ./ (abs(spectrum_lp)+eps);
18
19 %% We read silentnigh guitar.aif file
20 [s, fs] = audioread([notesfolder filesep listname(2).name]);
21 s = s(:, 1);
22 s = resample(s, 16000, fs);
23 spectrum_s = stft(s, 2048, 256, 0, hann(2048));
24 s_q=spectrum_s;
25

```

Command Window

```

In HW_1 (line 43)
>> Question_2_2
>> Question_2_2
>> Question_2_2
fx >>

```

Workspace

Name	Value
filename	'results/reconstructed_littlestar_guitar.wav'
fs	44100
fs_lp	44100
fsp	44100
l	448869x1 double
listname	3x1 struct
m	641562x1 double
notesfolder	'Audio'
reconstructedsignal_guitar	1x1226333 double
s	641562x1 double
s_lp	1025x1747 complex double
s_lq	1025x1747 complex double
s_p	1025x2500 complex double
s_q	1025x2500 complex double
s_sqlp	2500x1747 complex double
spectrum	1025x2500 complex double
spectrum_lp	1025x1747 complex double
spectrum_p	1025x2500 complex double
sphase	1025x2500 complex double
sphase_lp	1025x1747 complex double
sphase_lq	1025x1747 complex double
sphase_p	1025x2500 complex double
sphase_sqlp	2500x1747 complex double

4 usages of "reconstructedsignal_guitar" found

Aramak için buraya yazın

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MATLAB R2018a - academic use

HOME PLOTS APPS EDITOR PUBLISH VIEW

Insert Comment Indent Breakpoints Run Run and Advance Run Section Run and Time

Current Folder: C:\Users\ilker\OneDrive\Masaüstü\HW1_Matlab

Editor: C:\Users\ilker\OneDrive\Masaüstü\HW1_Matlab\Question_2.2.m

```

29 sphase=spectrum_s./(abs(spectrum_s)+eps);
30
31 %% We read silentnigh piano.aif file
32 [m, fsp] = audioread([notesfolder filesep listname(3).name]);
33 m = m(:, 1);
34 m = resample(m, 16000, fsp);
35 spectrum_p = stft(m, 2048, 256, 0, hann(2048));
36 s_p=spectrum_p;
37
38 s_p(find(s_p<max(s_p(:))/100)) = 0 ;
39 s_p = s_p/norm(s_p);
40
41 sphase_p=spectrum_p ./ (abs(spectrum_p)+eps);
42
43 %% Matrix transformation
44 % We calculate Lq = Sg * Sp^-1 * Lp
45 sphase_sqlp=pinv(sphase_p)*sphase_lp;
46 sphase_lq=sphase*sphase_sqlp;
47 s_sqlp=pinv(s_p)*s_lp;
48 l_q=s_q * s_sqlp;
49
50 reconstructedsignal_guitar=1000*stft(s_lq.*sphase_lq,2048,256,0,hann(2048));
51 reconstructedsignal_guitar = resample(reconstructedsignal_guitar, fs, 16000);
52
53 filename = 'results/reconstructed_littlestar_guitar.wav';
54 audiowrite(filename,reconstructedsignal_guitar,fs);
55

```

Command Window

```

In HW_1 (line 43)
>> Question_2_2
>> Question_2_2
>> Question_2_2
fx >>

```

Workspace

Name	Value
filename	'results/reconstructed_littlestar_guitar.wav'
fs	44100
fs_lp	44100
fsp	44100
l	448869x1 double
listname	3x1 struct
m	641562x1 double
notesfolder	'Audio'
reconstructedsignal_guitar	1x1226333 double
s	641562x1 double
s_lp	1025x1747 complex double
s_lq	1025x1747 complex double
s_p	1025x2500 complex double
s_q	1025x2500 complex double
s_sqlp	2500x1747 complex double
spectrum	1025x2500 complex double
spectrum_lp	1025x1747 complex double
spectrum_p	1025x2500 complex double
sphase	1025x2500 complex double
sphase_lp	1025x1747 complex double
sphase_lq	1025x1747 complex double
sphase_p	1025x2500 complex double
sphase_sqlp	2500x1747 complex double

4 usages of "reconstructedsignal_guitar" found

Aramak için buraya yazın

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MATLAB CODES

Q2.1)

```
%% We read the notes in note folder and get the spectrum.
clear all;

notesfolder = 'notes15';
listname = dir([notesfolder filesep '*.wav']);
notes = [];
for k = 1:length(listname)
    [s, fs] = audioread([notesfolder filesep
listname(k).name]);
    s = s(:, 1);
    s = resample(s, 16000, fs);
    spectrum = stft(s', 2048, 256, 0, hann(2048));
    %Find the central frame
    middle = ceil(size(spectrum, 2) / 2);
    note = abs(spectrum(:, middle));
    %Clean up everything more than 40 db below the peak
    note(find(note < max(note(:))/100)) = 0 ;
    note = note/norm(note);
    %normalize the note to unit length
    notes = [notes, note];
end

%% We read the 'polyushka'. We use stft function for spectrum.
[m, fs]=audioread("polyushka.wav");

m = resample(m, 16000, fs);
spectrum_m = stft(m', 2048, 256, 0, hann(2048));
note_m=spectrum_m;
sphase=spectrum_m./(abs(spectrum_m)+eps);
%% Matrix calculations
%  $NW = M \rightarrow W = N^{-1} * M$ 
% We find the inverse of N as using the 'pinv' function
% We did multiplication and reconstructing signal process
x = pinv(notes);
W= x * note_m;
W(find(W<0)) = 0 ;
W = real(W);
M=notes * W;

reconstructedsignal = stft(M.*sphase,2048,256,0,hann(2048));
reconstructedsignal = 100 * resample(reconstructedsignal, fs,
16000); % 40 db

filename = 'results/reconstructed_polyushka.wav';
```

```
audiowrite(filename,reconstructedsignal, fs);
```

```
%%
```

Q2.2)

```
%% Question 2.2
```

```
clear all;
```

```
notesfolder = 'Audio';
```

```
listname = dir([notesfolder filesep '*.aif']);
```

```
%% We read littlestar_piano.aif file
```

```
[l, fs_lp] = audioread([notesfolder filesep  
listname(1).name]);
```

```
l = l(:, 1);
```

```
l = resample(l, 16000, fs_lp);
```

```
spectrum_lp = stft(l', 2048, 256, 0, hann(2048));
```

```
s_lp=spectrum_lp;
```

```
s_lp(find(s_lp<max(s_lp(:))/100)) = 0 ;
```

```
s_lp = s_lp/norm(s_lp);
```

```
sphase_lp=spectrum_lp./(abs(spectrum_lp)+eps);
```

```
%% We read silentnigth_guitar.aif file
```

```
[s, fs] = audioread([notesfolder filesep listname(2).name]);
```

```
s = s(:, 1);
```

```
s = resample(s, 16000, fs);
```

```
spectrum = stft(s', 2048, 256, 0, hann(2048));
```

```
s_q=spectrum;
```

```
s_q(find(s_q<max(s_q(:))/100)) = 0 ;
```

```
s_q = s_q/norm(s_q);
```

```
sphase=spectrum./(abs(spectrum)+eps);
```

```
%% We read silentnigth_piano.aif file
```

```
[m, fsp] = audioread([notesfolder filesep listname(3).name]);
```

```
m = m(:, 1);
```

```
m = resample(m, 16000, fsp);
```

```
spectrum_p = stft(m', 2048, 256, 0, hann(2048));
```

```
s_p=spectrum_p;
```

```
s_p(find(s_p<max(s_p(:))/100)) = 0 ;
```

```
s_p = s_p/norm(s_p);
```

```

sphase_p=spectrum_p./(abs(spectrum_p)+eps);
%% Matrix transformation
% We calculate  $L_g = S_g * S_p^{-1} * L_p$ 
sphase_sqlp=pinv(sphase_p)*sphase_lp;
sphase_lq=sphase*sphase_sqlp;
s_sqlp=pinv(s_p)*s_lp;
s_lq=s_q * s_sqlp;

reconstructedsignal_guitar=1000*stft(s_lq.*sphase_lq,2048,256,
0,hann(2048));
reconstructedsignal_guitar =
resample(reconstructedsignal_guitar, fs, 16000);

filename = 'results/reconstructed_littlestar_guitar.wav';
audiowrite(filename,reconstructedsignal_guitar,fs);

```