MACHINE LEARNING FOR SIGNAL PROCESSING

HOMEWORK 1

İLKER BALTACI
040160237

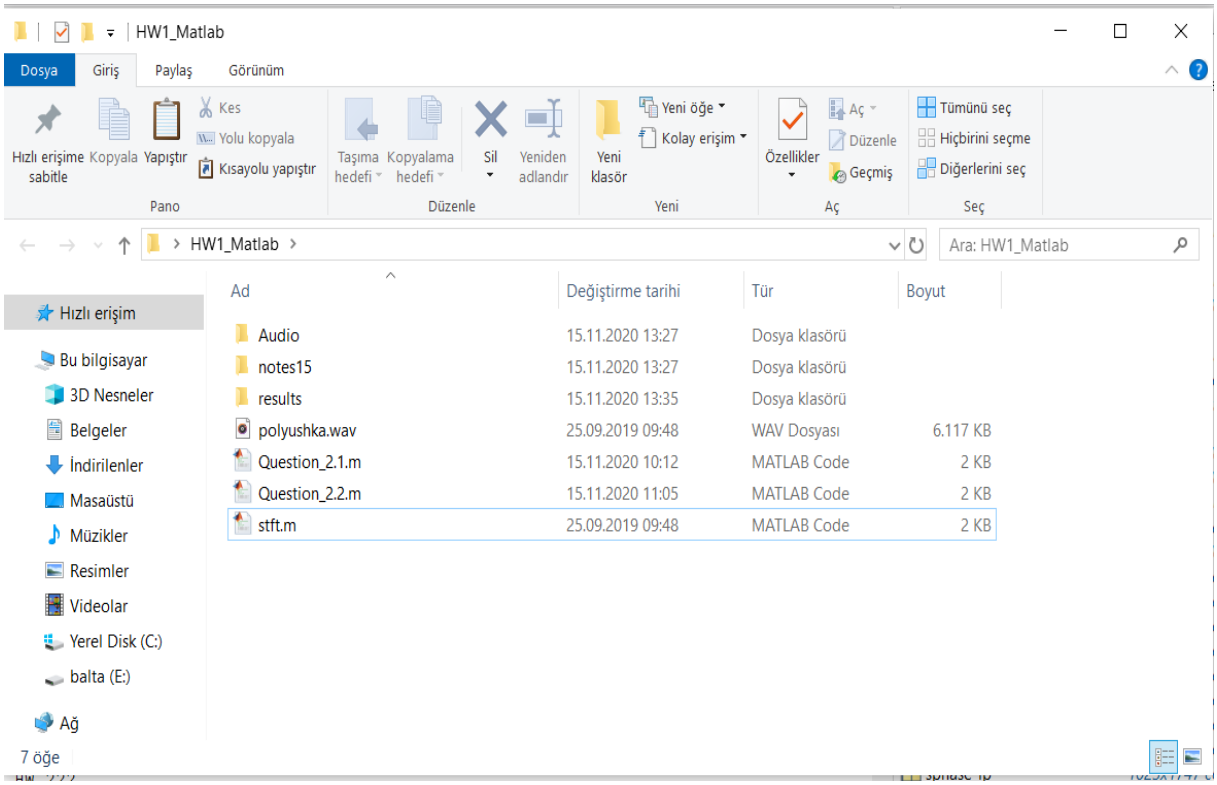
AHMET BEDRİ YORULMAZ
040160050

BURAK ŞİMŞEK
040160206

Question 2.1

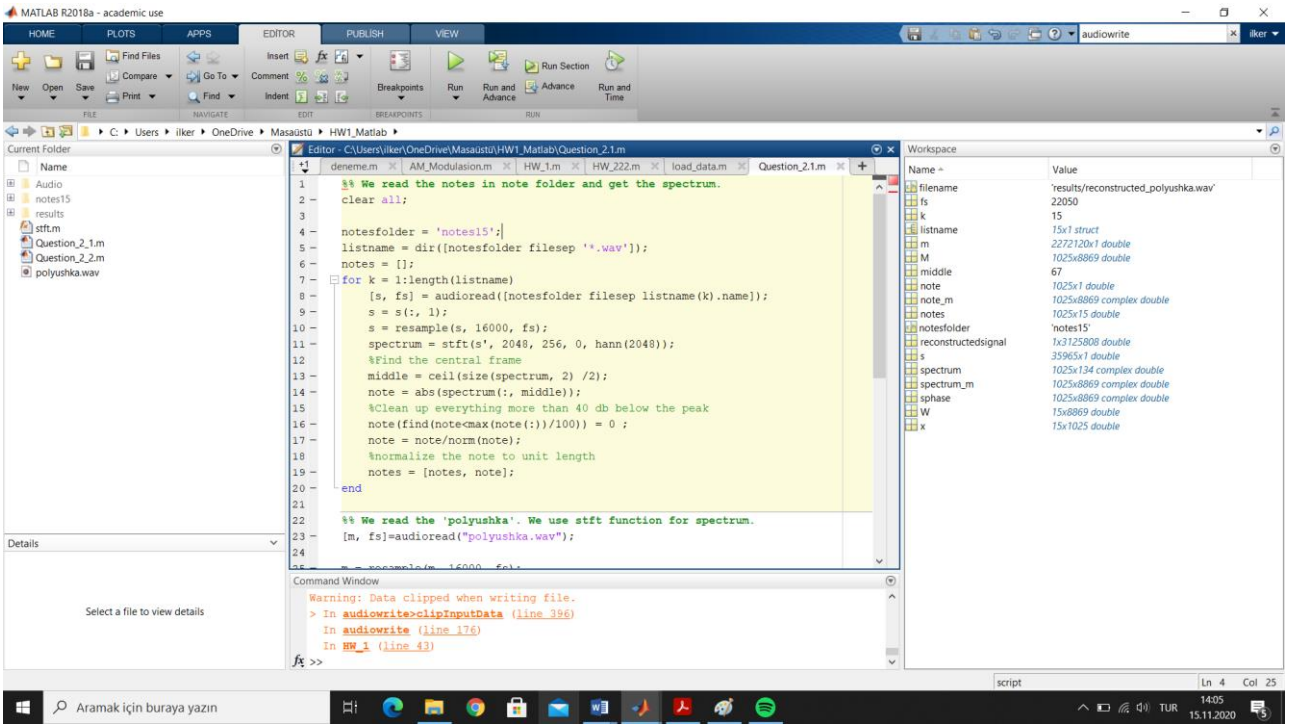
We created the matlab file called ‘Question_2.1.m’. To achieve the answer of the question 2.1, we applied all steps in one matlab file.

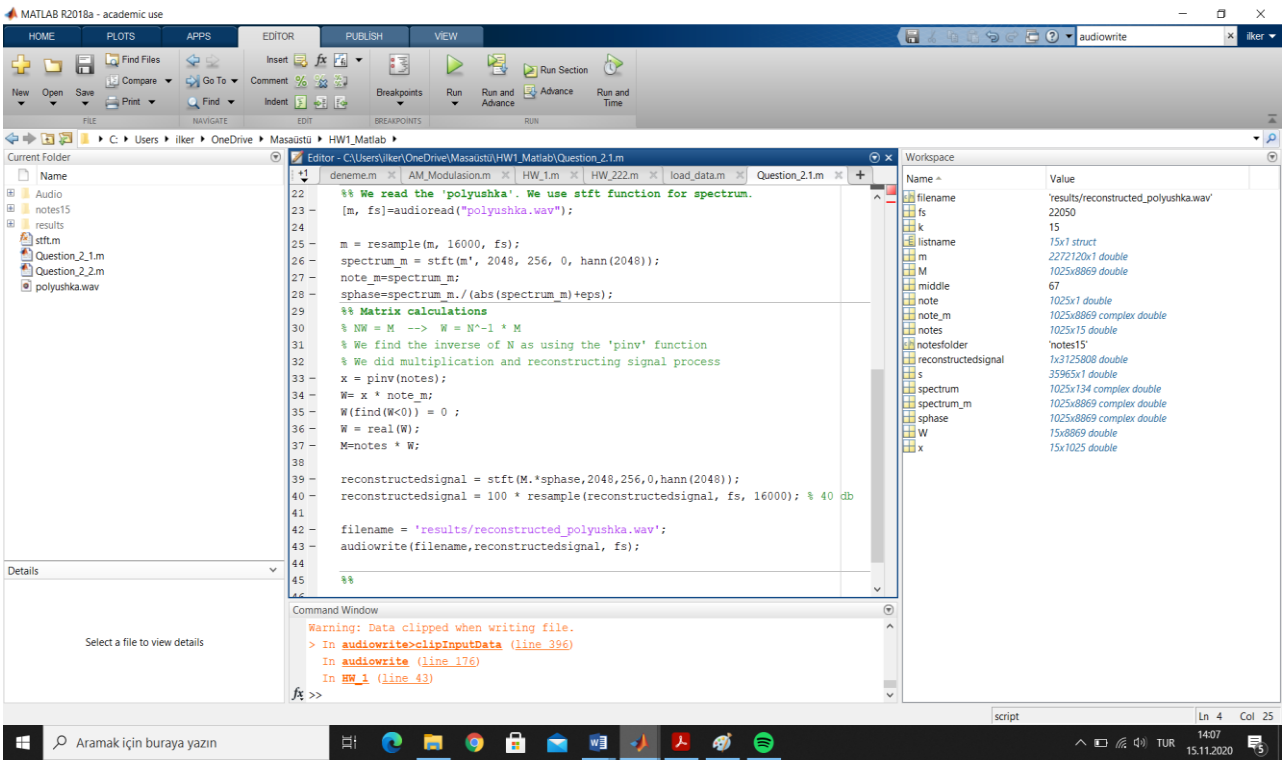
Firstly, when download the HW1_Matlab file, you must see a file shown below.



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’.

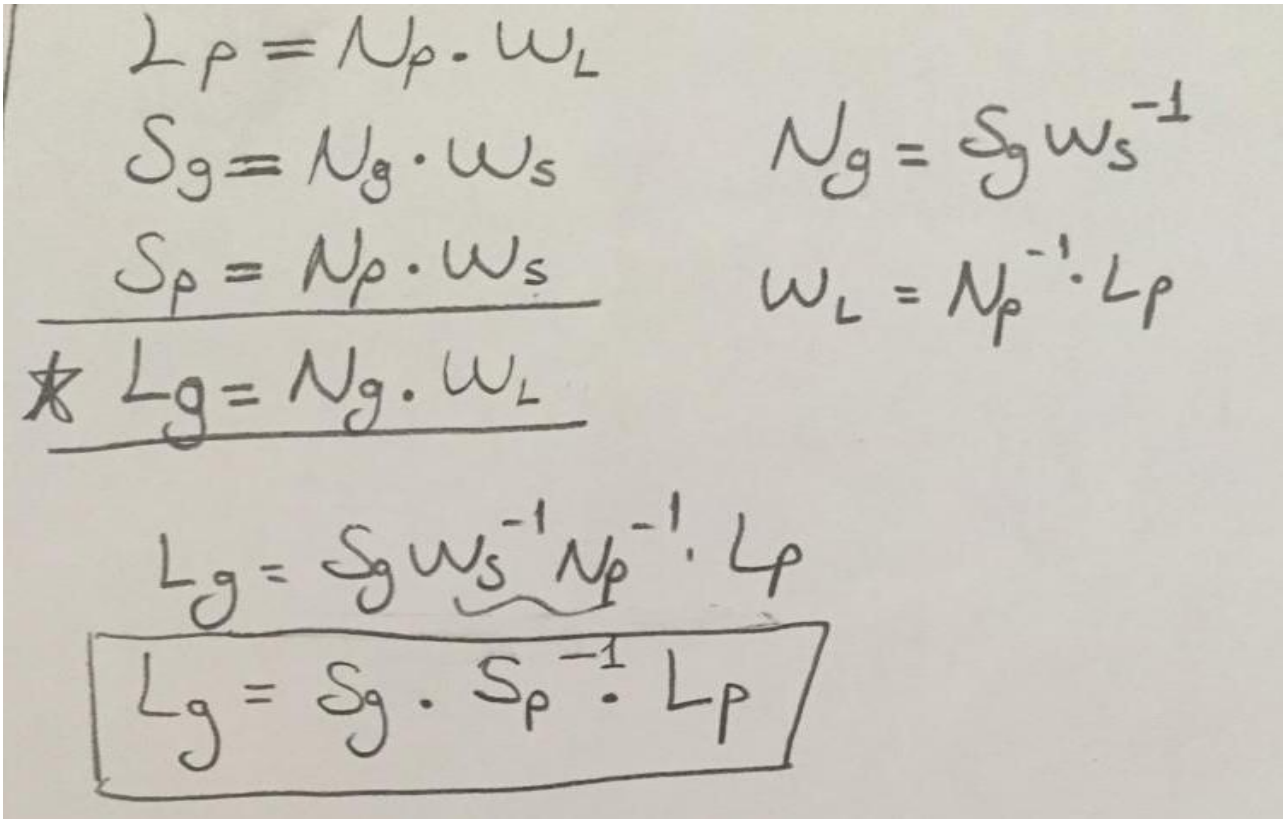
We read the notes in the note folder and get the spectrum. We applied the same steps for "polyushka.wav" file. After that, we did matrix operations to obtain the W matrix. To obtain inverse matrix of the notes matrix, we used pinv() function. We take real values in W matrix. Then, we created new music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



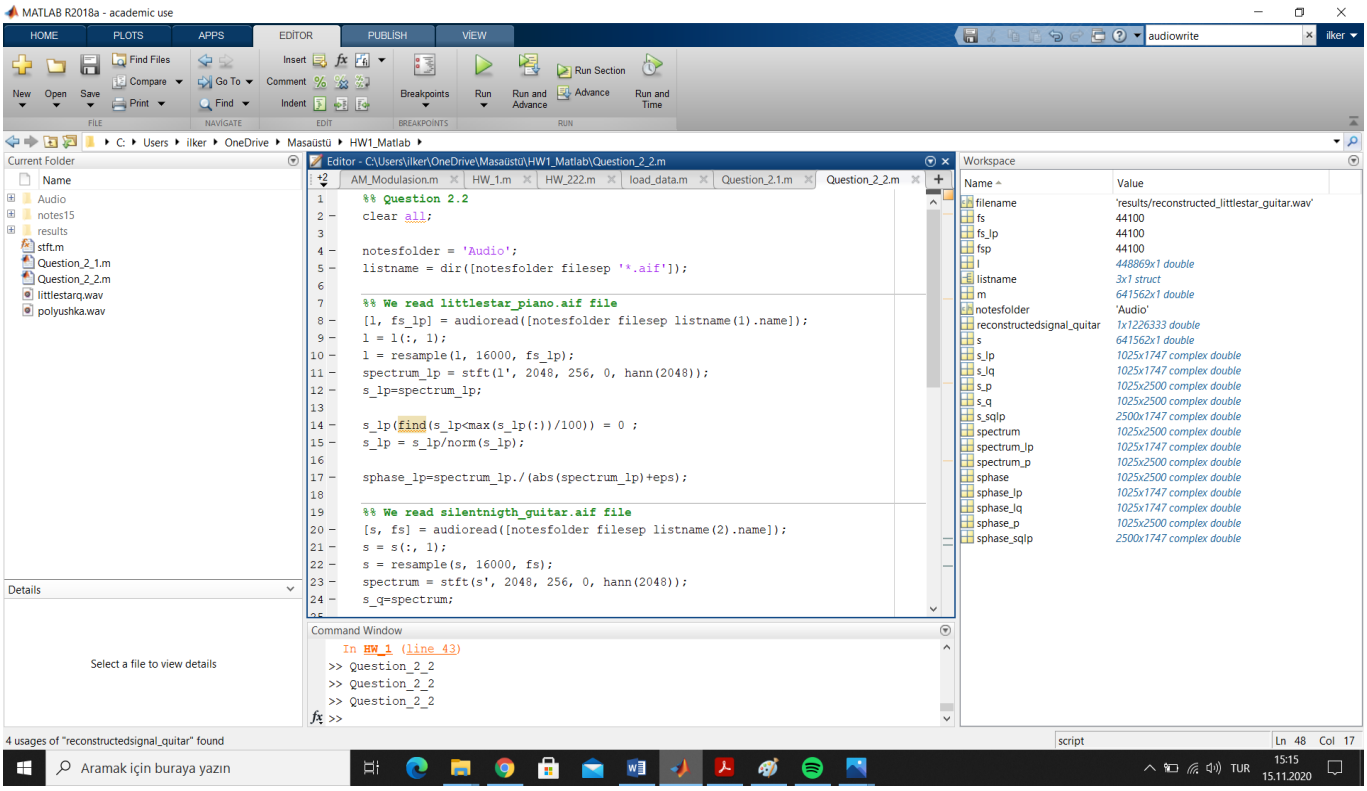


Question 2.2

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



We solved the equation with matlab and recovered the signal. Then, we created guitar version of littlestar song.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Current Folder
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Audio
notes15
results
stft.m
Question_2_1.m
Question_2_2.m
littlestarq.wav
polyushka.wav
Details
Select a file to view details
Editor - C:\Users\ilker\OneDrive\Masaüstü\HW1_Matlab\Question_2_2.m
AM_Modulasion.m
HW_1.m
HW_222.m
load_data.m
Question_2_1.m
Question_2_2.m
%% 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;
Command Window
In HW_1 (line 43)
>> Question_2_2
>> Question_2_2
>> Question_2_2
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
script
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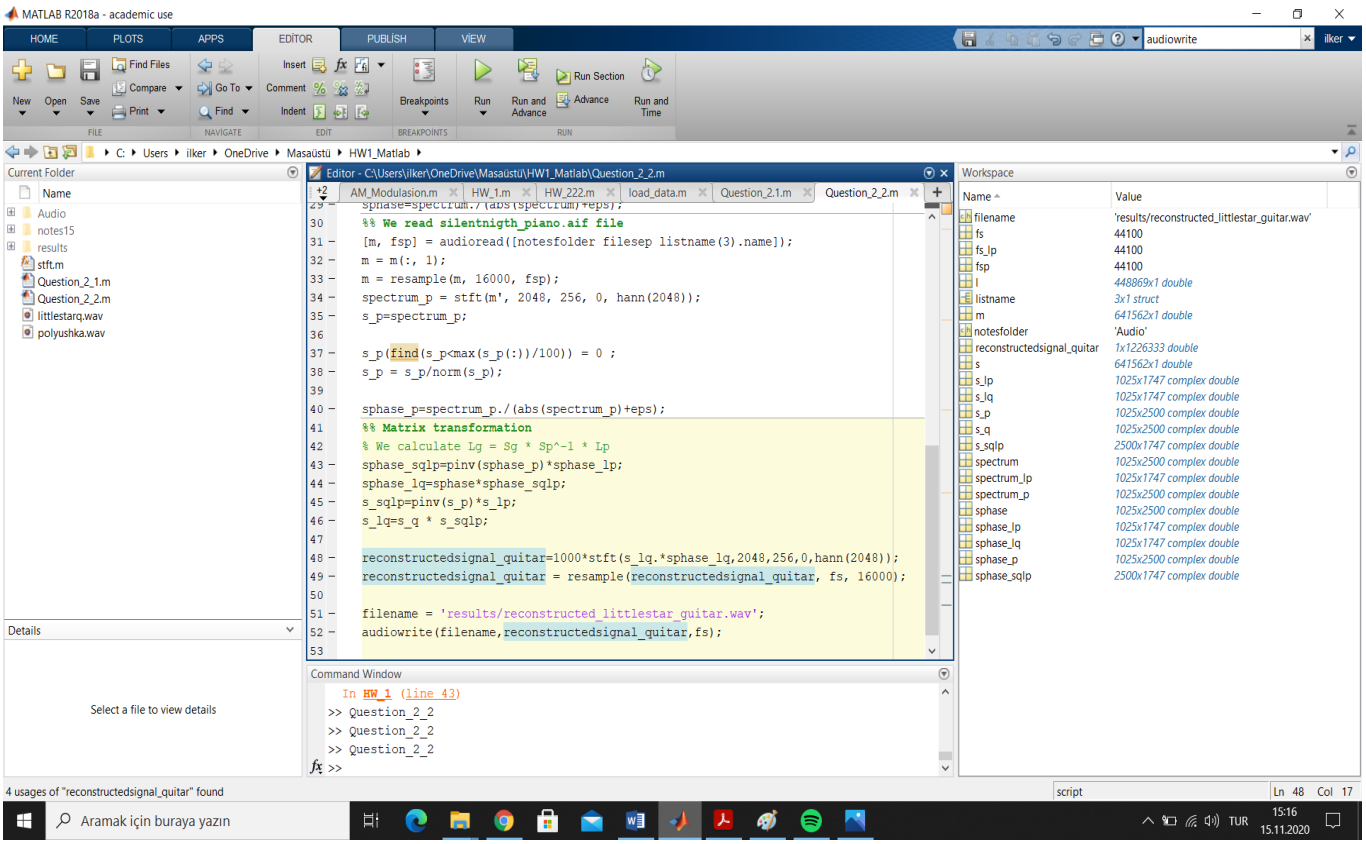
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Run Section
Advance
Run and Time
C: ▸ Users ▸ ilker ▸ OneDrive ▸ Masaüstü ▸ HW1_Matlab ▸
Current Folder
Name
Audio
notes15
results
stft.m
Question_2_1.m
Question_2_2.m
littlestarq.wav
polyushka.wav
Details
Select a file to view details
Editor - C:\Users\ilker\OneDrive\Masaüstü\HW1_Matlab\Question_2_2.m
AM_Modulasion.m
HW_1.m
HW_222.m
load_data.m
Question_2_1.m
Question_2_2.m
%% 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 Lg = Sg * Sp^-1 * Lp
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);
Command Window
In HW_1 (line 43)
>> Question_2_2
>> Question_2_2
>> Question_2_2
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
script
Ln 48 Col 17
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15.11.2020

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  -->  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 Lg = Sg * Sp^-1 * Lp
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_quitar=1000*stft(s_lq.*sphase_lq,2048,256,
0,hann(2048));
reconstructedsignal_quitar =
resample(reconstructedsignal_quitar, fs, 16000);

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