

Homework 3 (Due: Nov. 14th)

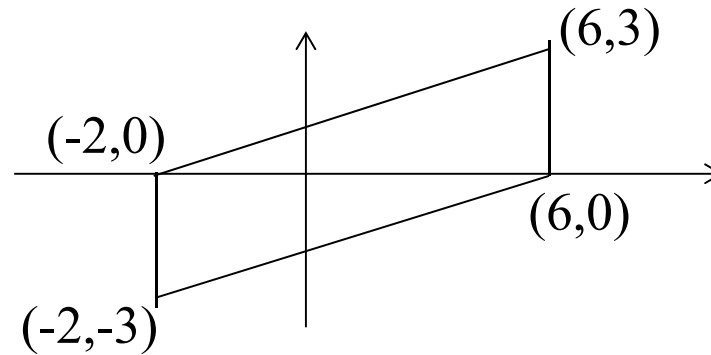
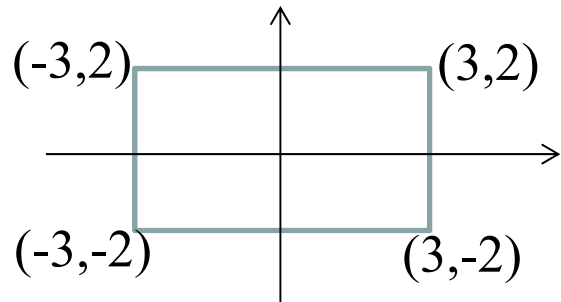
(1) (a) What are the two conditions where we cannot use Cohen's class distribution to remove the cross term? (b) What is the way to make the computation loading of the Cohen's class distribution less than 3 times of that of the WDF? (10 scores)

(2) The window of the S transform is $s(f)\exp(-\pi\tau^2s^2(f))$. Which of the following function is the best choice for $s(f)$? Why? (a) f^4 , (b) $1000-f^{0.6}$, (c) $50+10f^{0.5}$. (10 scores)

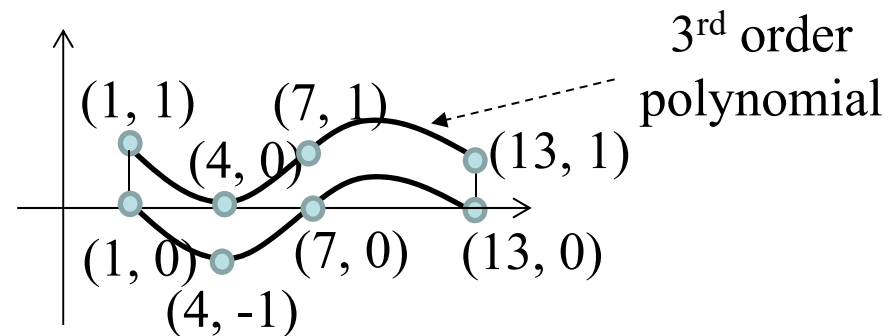
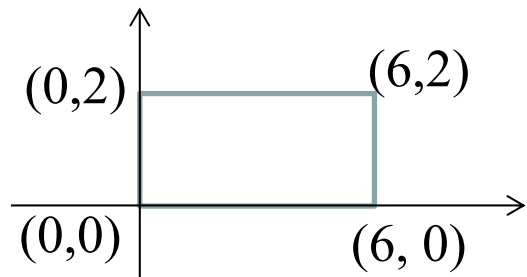
(3) (a) Compared to the original STFT, what is the advantage of time-frequency reassignment? (b) Compared to the original spectrogram, what is the advantage of the generalized spectrogram? (c) Compared to the Fourier series, what is the advantage of the 3-parameter atom? (15 scores)

(4) (a) Compared to the FT, what is the advantage of using the FRFT for filter design? (b) What is the condition where the noise cannot be removed even if the FRFT is applied? (10 scores)

(5) Suppose that the WDF of $x(t)$ is as the left subfigure. How do we change the time-frequency distribution into the right figure **with scaling, chirp multiplication, and shifting**? (10 scores)



(6) Suppose that the WDF of a signal is as the left figure. How do we change its WDF into the right figure? (10 scores)



(7) Write a Matlab or Python program for the scaled Gabor transform (unbalanced form).

$y = \text{Gabor}(x, \tau, t, f, \text{sgm})$ (35 scores)

x : input, τ : samples on t -axis for the input, t : samples on t -axis for the output

f : samples on f -axis, sgm : scaling parameter, y : output

(i) The code should be handed out by [NTU Cool](#), (ii) Choose an input x (Use [*.wav](#)) , plot the output y , (iii) Use [tic](#) and [toc](#) to show the running time , (iv) The running time for the following example should be [within 1.2 seconds](#).

```
[a1, fs] = audioread('Chord.wav');
x=a1(:,1).'; % only extract the first channel
tau = (? Please think how to determine tau);
dt = 0.01;          df= 1;      sgm= 200;
t= 0:dt:max(tau);  f= 20:df:1000;
tic
y= Gabor (x, tau, t, f, sgm);
toc
```

(Extra): Answer the questions according to your student ID number.

(ended with 0, 1, 3, 4, 5, 6, 8, 9)