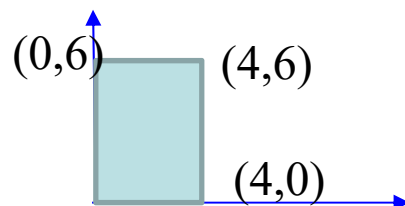


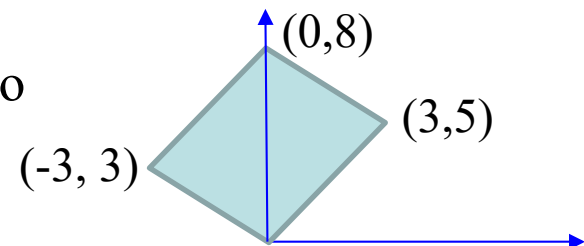
Homework 3 (Due: Nov. 16th)

(1) (a) Compared to the original STFT, what is the advantage of the S transform?
(b) Compared to the Fourier series, what is the advantage of the 3-parameter atom? (c) Compared to the original FT, what is the advantage of the FrFT in filter design? (15 scores)

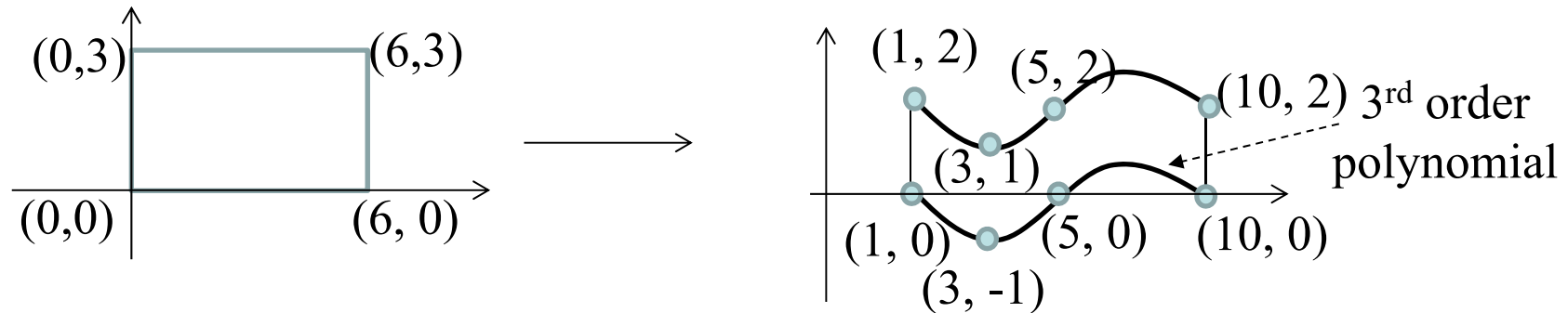
(2) Why using (a) time-frequency reassignment and (b) the Gabor-Wigner transform can obtain even clearer time-frequency distribution than using the original Gabor transform? (10 scores)

(3) Suppose that the WDF of $x(t)$ is  (10 scores)

(a) What is the WDF of $FT[\exp(j\pi t^2)x(t/2 - 1)]$?

(b) How do we convert the WDF into
by performing the LCT on $x(t)$?  (10 scores)

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



(5) Suppose that $X(t, f)$ is the STFT of $x(t)$ and $X(t, f) > \text{threshold}$ for $2t + f < 8$, $-t + 2f < 6$, and $f > 1$.

If $x(t)$ is interfered by white noise, how do we use two filters designed by the FrFTs together with one filter design by the FT to reduce the effect of noise?

(10 scores)

(6) Write a Matlab or a Python program for the Wigner distribution function when the input function has a finite duration.

$$y = \text{wdf}(x, t, f) \quad (35 \text{ scores})$$

x : input, t : samples on t -axis, f : samples on f -axis

(i) The code should be handed out by NTUCool, (ii) 用 `function` 的指令寫成函式, (iii) 自己選一個 input x , 用你們的程式將 output y 算出來並畫出來, (iv) 用 `tic` 和 `toc` 的指令來計算程式的 running time, (v) 程式執行的時間, 越短越好 (使用 `unbalanced form` 有額外加分)

Ex:

```
del_t = 0.0125; del_f = 0.025;
t = -9:del_t:9; f = -4:del_f:4;
x = exp(j*t.^2/10-j*3*t).*((t>=-9)&(t<=1))+exp(j*t.^2/2+j*6*t).*exp(-(t-4).^2/10);
tic
y=wdf(x,t,f);
toc
```

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

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