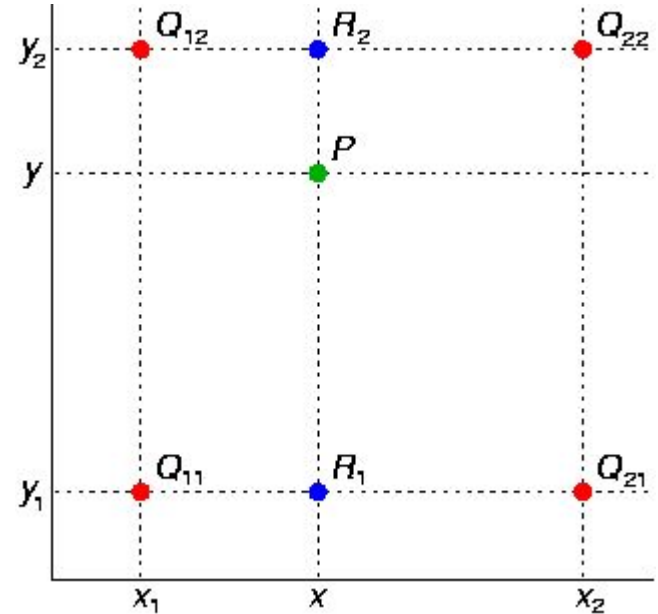# OS HW2

pthread

Technique:bilinear interpolation

Suppose that we want to find the value of the unknown function f at the point P = (x, y).

It is assumed that we know the value of f at the four points $Q_{11} = (x_1, y_1)$, $Q_{12} = (x_1, y_2)$, $Q_{21} = (x_2, y_1)$, and $Q_{22} = (x_2, y_2)$.
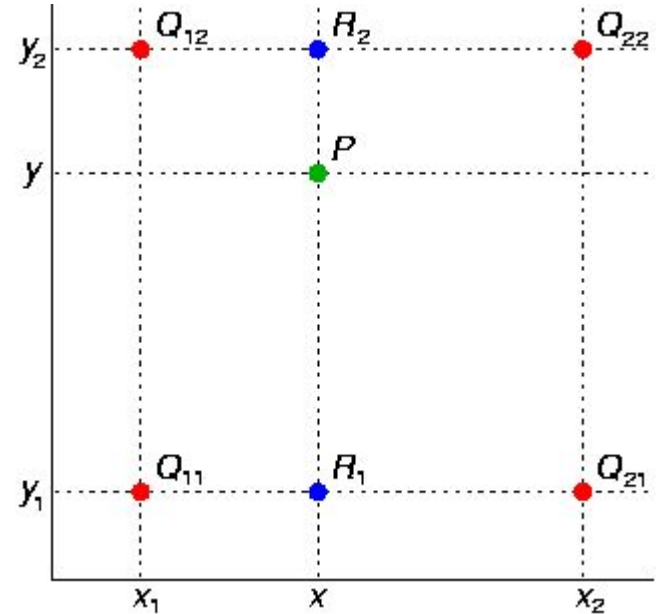
Technique:bilinear interpolation

We first do linear interpolation in the x-direction:

$$f(R_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}) \quad \text{where} \quad R_1 = (x, y_1),$$

$$f(R_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}) \quad \text{where} \quad R_2 = (x, y_2).$$

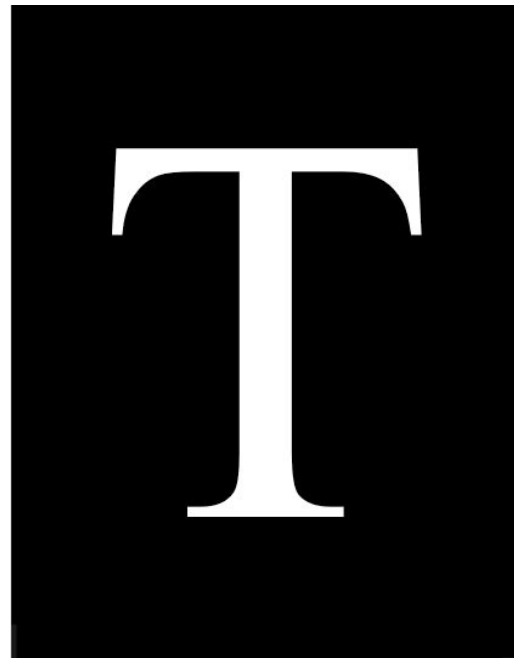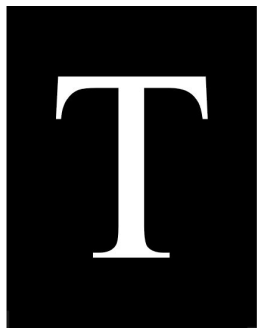We proceed by interpolating in the y direction to obtain the desired estimate:

$$f(P) \approx \frac{y_2 - y}{y_2 - y_1} f(R_1) + \frac{y - y_1}{y_2 - y_1} f(R_2).$$

$$f(x, y) \approx \frac{f(Q_{11})}{(x_2 - x_1)(y_2 - y_1)}(x_2 - x)(y_2 - y) + \frac{f(Q_{21})}{(x_2 - x_1)(y_2 - y_1)}(x - x_1)(y_2 - y)$$

$$+ \frac{f(Q_{12})}{(x_2 - x_1)(y_2 - y_1)}(x_2 - x)(y - y_1) + \frac{f(Q_{22})}{(x_2 - x_1)(y_2 - y_1)}(x - x_1)(y - y_1).$$
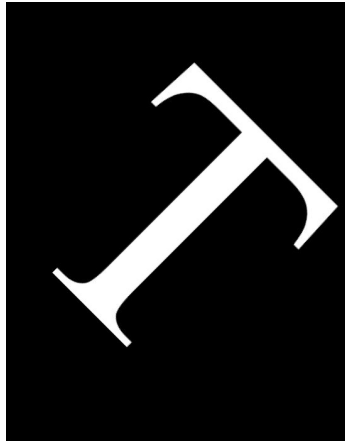
Technique:bilinear interpolation

ratio = 4

Technique:rotation

ratation matrix:
$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

$$\Rightarrow \begin{cases} x' = x\cos\theta - y\sin\theta \\ y' = y\cos\theta + x\sin\theta \end{cases}$$
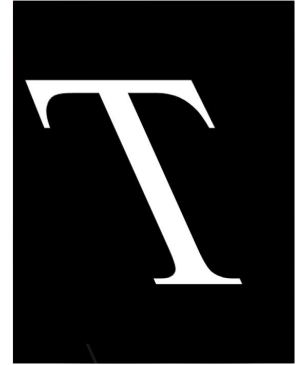
angle = 45° :

Technique:shear

- A shear parallel to the x axis :
  results in $x' = x + \lambda y$ and $y' = y$.
  In matrix form:
  $$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & \lambda \\ 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$\lambda' = 0.45$

- A shear parallel to the y axis :
  results in $x' = x$ and $y' = y + \lambda x$
  In matrix form:
  $$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ \lambda & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$\lambda' = 0.45$

input

An image named "input.bmp"

TAs will test by using any image

you can use bmpReader.h to read the input bmp

(Don't modify bmpReader.h)

output

you need to output five images

- ~~output1.bmp : bilinear interpolation(ratio = 7)~~
- ~~output2.bmp : bilinear(ratio = 7) + rotation(angle = 45°)~~
- ~~output3.bmp : bilinear(ratio = 7) + shear(vertical lambda = 0.3)~~
- ~~output4.bmp : bilinear(ratio = 7) + shear(horizontal lambda = 0.6)~~
- output5.bmp : bilinear(ratio = 7) + shear(sv = 0.45) + rotation(angle = 60°) + shear(sh = 0.45)

and print the elapsed time both without using pthread and using pthread

example

input :

input.bmp

output : five images and elapsed time

output1.bmp

output2.bmp

output3.bmp

output4.bmp

output5.bmp

```
Without using pthread:
Write output1.bmp
Write output2.bmp
Write output3.bmp
Write output4.bmp
Write output5.bmp
6.251403 seconds
Using pthread:
Write output1.bmp
Write output4.bmp
Write output3.bmp
Write output2.bmp
Write output5.bmp
4.668640 seconds
```

About this program

- In OS_HW2.cpp, search "TODO" to find where and what you have to modifiy
  - ~~Line~~ 19: add your pthread codes to speed up the program
  - ~~Line 62~~: modify (ID) to your student ID
  - ~~Line 65~~: add your pthread codes to speed up the program
  - Line 90: bilinear
  - ~~Line 200~~: shear_horizontal

Requirements

- deadline : 2018/11/27 23:55
- upload you code to New e3 before deadline and named studentID_hw2.zip
  - including your code (file name: studentID_hw2.cpp) and bmpReader.h (5 points)
- the output images must be correct (70 points)
- print the elapsed time both without using pthread and using pthread(5 points)
  - using pthread must speed up this program
- print the speed up rate (20 points)
  - for example: elapsed time without pthread: 6 sec, with pthread: 3 sec, speed up rate=2
  - your speed up rate must be the largest one in the class to get the full 20 points.
  - for the others, we will interpolate your rate with the largest one in the class and 1.
  - if your speed up rate is below 1, you will get (-10 points)
- violating any requirement above will get score penalty

APIs

- pthread_create() - create a new thread
  - http://man7.org/linux/man-pages/man3/pthread_create.3.html
- pthread_join() - join with a terminated thread
  - http://man7.org/linux/man-pages/man3/pthread_join.3.html
- pthread_exit() - terminate calling thread
  - http://man7.org/linux/man-pages/man3/pthread_exit.3.html
- gettimeofday() - get the time when start / end calculating to compute the elapsed time
  - http://man7.org/linux/man-pages/man2/gettimeofday.2.html

testing environment

use **g++ -pthread** to compile your code

- ubuntu 16.04
- ubuntu 14.04
- CS linux work station

your code should compile successfully in one of the above environments!