Senni Tan 400196392

fib.c

```
#include "bmp.h"
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
/*determine the lenth of the nth fibonacci word*/
int fib_size(int n){
	if (n==0)	return 0;
	if ( n==1 || n==2 )	return 1;
	return fib_size(n-1) + fib_size(n-2);
}
/*make the fibonacci string*/
char * fibword(int n){
	int len = fib_size(n);
	char *word = malloc((len+1) * sizeof(char));
	char *tmp = malloc((len+1) * sizeof(char));
	char *Sn_1 = malloc((len+1) * sizeof(char));
	char *Sn = malloc((len+1) * sizeof(char));
	char one[2] = {'1'};
	char zero[2] = {'0'};
	char zero_one[3] = {'0','1'};

	if (n==0) return NULL;
	if (n==1) {
		strcpy(word,one);
		free(tmp);
		free(Sn);
		free(Sn_1);
		return word;
	}
	if (n==2) {
		strcpy(word,zero);
		free(tmp);
		free(Sn);
		free(Sn_1);
		return word;
	}

	if (n==3) {
		strcpy(word,zero_one);
		free(tmp);
		free(Sn);
		free(Sn_1);
```

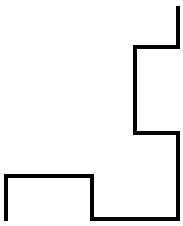
```
            return word;
        }
        strcpy(Sn_1,zero);
        strcpy(Sn,zero_one);
        n-=1;
        int i;
        for (i = 3; i <= n; i++){
            strcpy(tmp,Sn);
            strcat(Sn,Sn_1);
            strcpy(Sn_1, tmp);
        }

        strcpy(word, Sn);
        free(tmp);
        free(Sn);
        free(Sn_1);

        return word;
}
/*direction*/
typedef enum {
        up,
        down,
        left,
        right
} direction;
/*draw a segment*/
void draw(int x, int y, direction dir, int step, int w, RGB* im, RGB c){
#define I(i, j) im[(i)*w + j]
        int j;
        if (dir == up)
            for (j = 0; j < step; j++)
                I(x + j, y) = c;
        if (dir == down)
            for (j = 0; j < step; j++)
                I(x - j, y) = c;
        if (dir == right)
            for (j = 0; j < step; j++)
                I(x, y + j) = c;
        if (dir == left)
            for (j = 0; j < step; j++)
                I(x, y - j) = c;
#undef I
}
```

```
/*make a turn in direction*/
direction turn(direction dir, direction to_turn90){
	if (to_turn90 == right){
		if (dir == up){
			return right;
		}
		if (dir == right){
			return down;
		}
		if (dir == down){
			return left;
		}
		if (dir == left){
			return up;
		}
	}
	if (to_turn90 == left){
		if (dir == up){
			return left;
		}
		if (dir == left){
			return down;
		}
		if (dir == down){
			return right;
		}
		if (dir == right){
			return up;
		}

	}
}
/*determine if a num is even or not*/
int is_even(int i){
	if ((i%2) == 0){
		return 1;
	}
	if ((i%2) == 1){
		return 0;
	}
}

int fib(int n, int x, int y, int step, RGB b, RGB f, int w, int h, RGB* image){
	char *fn = fibword(n);
```

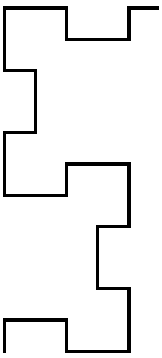
```
    if (!fn)    return 0;
    int i;
    /*set blackground*/
    for (i = 0; i < w * h; i++)
        image[i] = b;
    int len = strlen(fn);
    int dig = 0;
    direction dir = up;
    for (i = 1; i <= len && x < w && y < h; i++){
        dig = fn[i-1] - '0';
        draw(x, y, dir, step, w, image, f);
        switch (dir){
            case (up):
                x += step;
                break;
            case (right):
                y += step;
                break;
            case (down):
                x -= step;
                break;
            case (left):
                y -= step;
                break;
            default:
                break;
        }
        if (dig == 0){
            if (is_even(i)){
                dir = turn(dir, left);
            }
            else{
                dir = turn(dir, right);
            }
        }
        if (dig == 1){
            dir = dir;
        }
    }
    free(fn);
    if ((i-1) != len)
        return 0;
    return len;
}
```

makefile.b

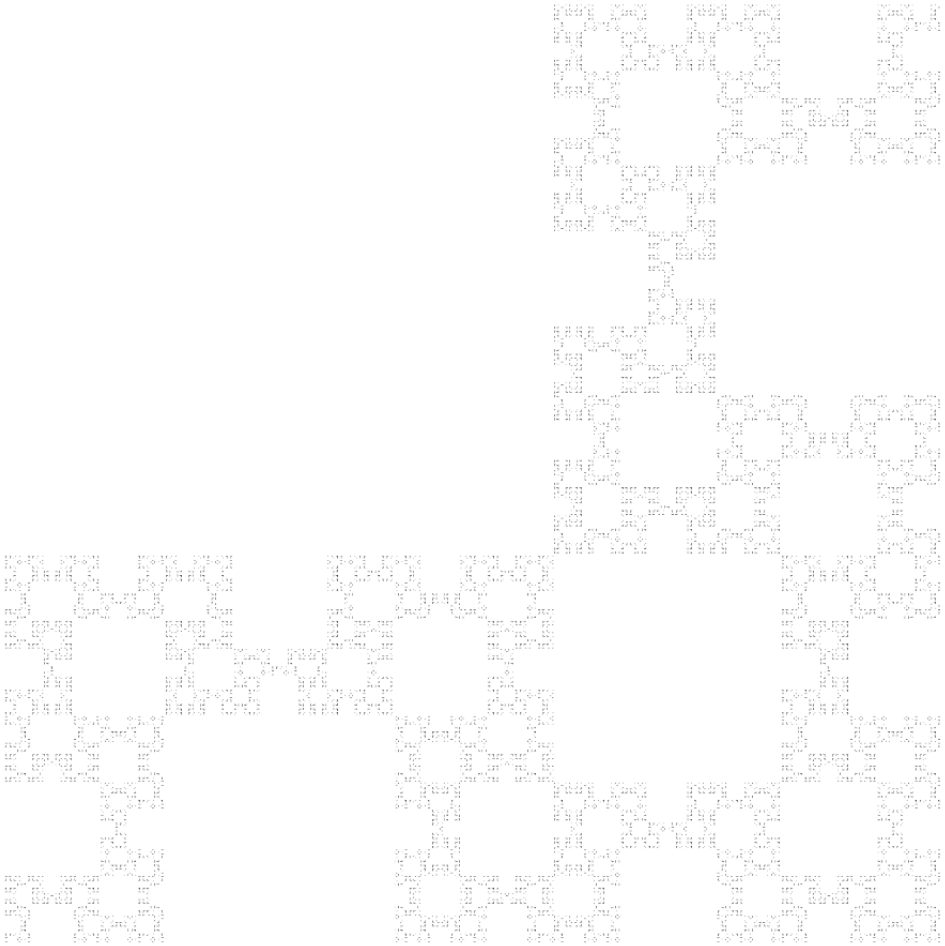
```
CFLAGS=-Wall -O2 -ansi
fib: main_fib.o fib.o bmp.o timing.o
	$(CXX) -o fib $?
runall:
	./fib 7 10 10 10 100 100 fib7.bmp
	./fib 9 10 10 10 300 300 fib9.bmp
	./fib 25 10 10 10 10000 10000 fib25.bmp
	./fib 26 10 10 10 20000 20000 fib26.bmp

clean:
	@rm -rf fib *.o *bmp
```



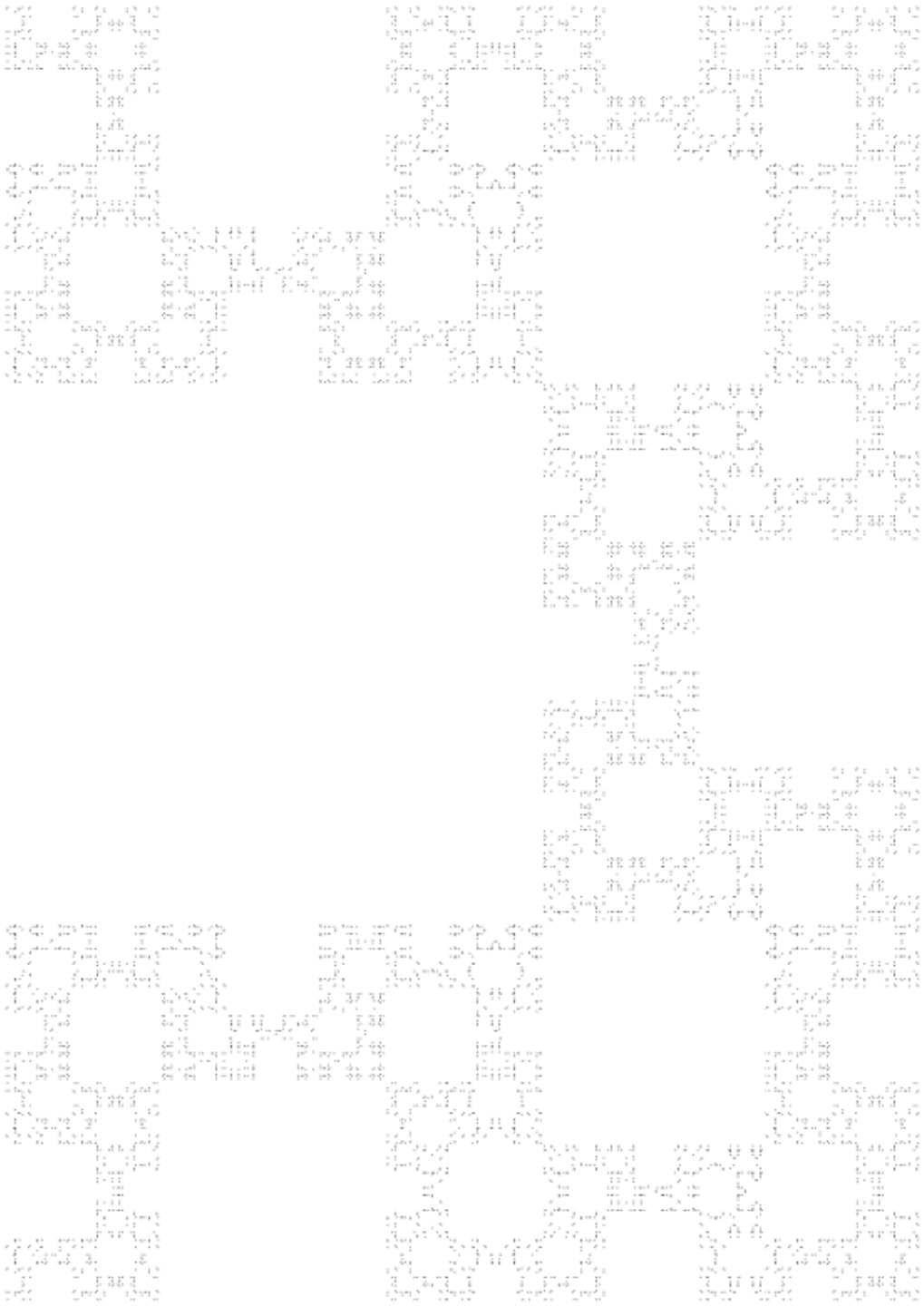
n = 7



n = 9



n = 25



n = 26

Problem 2

Flat profile:

Each sample counts as 0.01 seconds.

% time	cumulative seconds	self seconds	calls	self ms/call	total ms/call	name
17.98	2.30	2.30				fib_size (fib.c:9 @ 400bc2)
12.66	3.93	1.62				saveBMP (bmp.c:25 @ 4011ab)
10.20	5.24	1.31				fib_size (fib.c:11 @ 400b98)
8.60	6.34	1.10				draw (fib.c:71 @ 400bf2)
5.94	7.10	0.76				draw (fib.c:87 @ 400c24)
5.63	7.82	0.72				fib_size (fib.c:11 @ 400bb8)
4.61	8.41	0.59	1	591.26	591.26	draw (fib.c:71 @ 400bd0)
4.30	8.96	0.55				saveBMP (bmp.c:15 @ 4011a3)
4.30	9.52	0.55				saveBMP (bmp.c:27 @ 4011bd)
3.67	9.99	0.47				saveBMP (bmp.c:26 @ 4011ae)
3.20	10.40	0.41				fib_size (fib.c:10 @ 400b88)
2.89	10.77	0.37				draw (fib.c:75 @ 400c1d)
2.50	11.09	0.32				saveBMP (bmp.c:14 @ 40118f)
1.60	11.29	0.21				saveBMP (bmp.c:15 @ 40119c)
1.49	11.48	0.19				draw (fib.c:75 @ 400c10)
1.49	11.67	0.19				draw (fib.c:76 @ 400c13)
1.49	11.87	0.19				saveBMP (bmp.c:25 @ 4011a0)
1.41	12.05	0.18				saveBMP (bmp.c:31 @ 4011b5)
1.37	12.22	0.18				fib_size (fib.c:8 @ 400b92)
1.25	12.38	0.16				draw (fib.c:74 @ 400bec)
1.25	12.54	0.16				draw (fib.c:75 @ 400bee)
0.55	12.61	0.07				fib_size (fib.c:9 @ 400bb4)
0.31	12.65	0.04				draw (fib.c:77 @ 400c30)
0.23	12.68	0.03				fib (fib.c:135 @ 400f4f)
0.23	12.71	0.03				fib (fib.c:141 @ 400f8d)
0.16	12.73	0.02				fib (fib.c:131 @ 400f45)
0.12	12.75	0.02				saveBMP (bmp.c:25 @ 40119a)
0.08	12.76	0.01				fib (fib.c:138 @ 400f7f)
0.08	12.77	0.01				fib (fib.c:141 @ 400fc9)
0.08	12.78	0.01				fib (fib.c:144 @ 401019)
0.08	12.79	0.01				fib (fib.c:141 @ 40105f)
0.08	12.80	0.01				saveBMP (bmp.c:26 @ 4011ba)
0.08	12.81	0.01				saveBMP (bmp.c:43 @ 4012a6)
0.04	12.81	0.01				fib (fib.c:141 @ 401059)
0.04	12.82	0.01				fib (fib.c:162 @ 40105c)
0.04	12.82	0.01				fib (fib.c:172 @ 40106c)
0.04	12.83	0.01				fib (fib.c:173 @ 401075)
0.00	12.83	0.00	1346269	0.00	0.00	fib (fib.c:130 @ 400f00)
0.00	12.83	0.00	514230	0.00	0.00	saveBMP (bmp.c:6 @ 4010e0)
0.00	12.83	0.00	3	0.00	0.00	main (main_fib.c:9 @ 400890)

0.00 12.83 0.00 1 0.00 0.00 turn (fib.c:89 @ 400d00)

% time the percentage of the total running time of the program used by this function.

cumulative seconds a running sum of the number of seconds accounted for by this function and those listed above it.

self seconds the number of seconds accounted for by this function alone. This is the major sort for this listing.

calls the number of times this function was invoked, if this function is profiled, else blank.

self ms/call the average number of milliseconds spent in this function per call, if this function is profiled, else blank.

total ms/call the average number of milliseconds spent in this function and its descendents per call, if this function is profiled, else blank.

name the name of the function. This is the minor sort for this listing. The index shows the location of the function in the gprof listing. If the index is in parenthesis it shows where it would appear in the gprof listing if it were to be printed.

Call graph (explanation follows)

granularity: each sample hit covers 2 byte(s) for 0.08% of 12.83 seconds

```
index % time    self  children    called     name
                0.59    0.00       1/1          turn (fib.c:108 @ 400d1c) [8]
[7]     4.6     0.59    0.00       1            draw (fib.c:71 @ 400bd0) [7]
-----------------------------------------------
                0.00    0.00  257114/1346269     saveBMP (bmp.c:42 @ 4012a0) [261]
                0.00    0.00  257115/1346269     saveBMP (bmp.c:40 @ 401290) [260]
                0.00    0.00  832040/1346269     saveBMP (bmp.c:39 @ 401224) [256]
[39]    0.0     0.00    0.00 1346269             fib (fib.c:130 @ 400f00) [39]
-----------------------------------------------
                0.00    0.00       1/514230      _fini [287]
                0.00    0.00  514229/514230      saveBMP (bmp.c:5 @ 401269) [259]
```

```
[40]     0.0    0.00    0.00  514230          saveBMP (bmp.c:6 @ 4010e0) [40]
-----------------------------------------------
                0.00    0.00     1/3            __do_global_ctors_aux [283]
                0.00    0.00     2/3            _fini [287]
[41]     0.0    0.00    0.00       3          main (main_fib.c:9 @ 400890) [41]
-----------------------------------------------
                0.00    0.00     1/1            saveBMP (bmp.c:23 @ 401170) [238]
[42]     0.0    0.00    0.00       1          turn (fib.c:89 @ 400d00) [42]
-----------------------------------------------
```

This table describes the call tree of the program, and was sorted by
the total amount of time spent in each function and its children.

Each entry in this table consists of several lines. The line with the
index number at the left hand margin lists the current function.
The lines above it list the functions that called this function,
and the lines below it list the functions this one called.
This line lists:

index A unique number given to each element of the table.
Index numbers are sorted numerically.
The index number is printed next to every function name so
it is easier to look up where the function in the table.

% time This is the percentage of the `total' time that was spent
in this function and its children. Note that due to
different viewpoints, functions excluded by options, etc,
these numbers will NOT add up to 100%.

self This is the total amount of time spent in this function.

children This is the total amount of time propagated into this
function by its children.

called This is the number of times the function was called.
If the function called itself recursively, the number
only includes non-recursive calls, and is followed by
a `+' and the number of recursive calls.

name The name of the current function. The index number is
printed after it. If the function is a member of a
cycle, the cycle number is printed between the
function's name and the index number.

For the function's parents, the fields have the following meanings:

self This is the amount of time that was propagated directly from the function into this parent.

children This is the amount of time that was propagated from the function's children into this parent.

called This is the number of times this parent called the function `/' the total number of times the function was called. Recursive calls to the function are not included in the number after the `/'.

name This is the name of the parent. The parent's index number is printed after it. If the parent is a member of a cycle, the cycle number is printed between the name and the index number.

If the parents of the function cannot be determined, the word `<spontaneous>' is printed in the `name' field, and all the other fields are blank.

For the function's children, the fields have the following meanings:

self This is the amount of time that was propagated directly from the child into the function.

children This is the amount of time that was propagated from the child's children to the function.

called This is the number of times the function called this child `/' the total number of times the child was called. Recursive calls by the child are not listed in the number after the `/'.

name This is the name of the child. The child's index number is printed after it. If the child is a member of a cycle, the cycle number is printed between the name and the index number.

If there are any cycles (circles) in the call graph, there is an entry for the cycle-as-a-whole. This entry shows who called the cycle (as parents) and the members of the cycle (as children.) The `+' recursive calls entry shows the number of function calls that

were internal to the cycle, and the calls entry for each member shows,
for that member, how many times it was called from other members of
the cycle.

Index by function name

[7] draw (fib.c:71 @ 400bd0) [30] fib (fib.c:141 @ 400fc9) [40] saveBMP (bmp.c:6 @ 4010e0)
[21] draw (fib.c:74 @ 400bec) [31] fib (fib.c:144 @ 401019) [14] saveBMP (bmp.c:14 @ 40118f)
[22] draw (fib.c:75 @ 400bee) [35] fib (fib.c:141 @ 401059) [28] saveBMP (bmp.c:25 @ 40119a)
[4] draw (fib.c:71 @ 400bf2) [36] fib (fib.c:162 @ 40105c) [15] saveBMP (bmp.c:15 @ 40119c)
[16] draw (fib.c:75 @ 400c10) [32] fib (fib.c:141 @ 40105f) [18] saveBMP (bmp.c:25 @ 4011a0)
[17] draw (fib.c:76 @ 400c13) [37] fib (fib.c:172 @ 40106c) [9] saveBMP (bmp.c:15 @ 4011a3)
[13] draw (fib.c:75 @ 400c1d) [38] fib (fib.c:173 @ 401075) [2] saveBMP (bmp.c:25 @ 4011ab)
[5] draw (fib.c:87 @ 400c24) [12] fib_size (fib.c:10 @ 400b88) [11] saveBMP (bmp.c:26 @ 4011ae)
[24] draw (fib.c:77 @ 400c30) [20] fib_size (fib.c:8 @ 400b92) [19] saveBMP (bmp.c:31 @ 4011b5)
[39] fib (fib.c:130 @ 400f00) [3] fib_size (fib.c:11 @ 400b98) [33] saveBMP (bmp.c:26 @ 4011ba)
[27] fib (fib.c:131 @ 400f45) [23] fib_size (fib.c:9 @ 400bb4) [10] saveBMP (bmp.c:27 @ 4011bd)
[25] fib (fib.c:135 @ 400f4f) [6] fib_size (fib.c:11 @ 400bb8) [34] saveBMP (bmp.c:43 @ 4012a6)
[29] fib (fib.c:138 @ 400f7f) [1] fib_size (fib.c:9 @ 400bc2) [42] turn (fib.c:89 @ 400d00)
[26] fib (fib.c:141 @ 400f8d) [41] main (main_fib.c:9 @ 400890)

The first line of my fib function takes most of the time. The first line in fib function calls a subfunction “fib_size” which calculate the nth Fibonacci word’s length with recursion. The recursion waits for the stack of the base case return back, that’s why it takes the most of the time.

filter.c

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

typedef struct pixel {
```

```
    unsigned char r, g, b;
} Pixel;

typedef struct image {
    unsigned int width, height, max;
    Pixel **data;
} Image;

void printPPM(Image *image) {
    int i,j;
    for (i=0; i< image->height; i++){
        for (j=0; j< image->width; j++){
            printf("#%02x%02x%02x", image->data[i][j].r, image->data[i][j].g,
image->data[i][j].b);
        }
        printf("\n");
    }
}

Image *readPPM(char *file_name) {

    FILE *file = fopen(file_name, "r");
    if (!file) {
        fprintf(stderr, "Unable to open file \"%s\"\n", file_name);
        return NULL;
    }

    char format[3];
    /*fscanf(file, "%2s\n", format);*/
    if(fscanf(file, "%s\n", format) != 1)
        return NULL;
    if (strcmp(format, "P3"))
        return NULL;

    Image *image = malloc(sizeof(Image));

    if(fscanf(file, "%u %u %u", &image->width, &image->height, &image->max) != 3)
        return NULL;

    image->data = malloc(sizeof(Pixel *) * image->height);
    int i, j;
    for (i = 0; i < image->height; i++)
        image->data[i] = malloc(sizeof(Pixel) * image->width);
```

```
    for (i = 0; i < image->height; i++)
        for (j = 0; j < image->width; j++){
            int pixels_read = fscanf(file, "%hhu %hhu %hhu", &(image->data[i][j].r),
&(image->data[i][j].g), &(image->data[i][j].b));

            if (pixels_read != 3)
                return NULL;
        }

    fclose(file);
    return image;
}

int writePPM(char *file_name, Image *image){

    FILE *file = fopen(file_name, "w");
    if (!file) {
        fprintf(stderr, "Unable to open file \"%s\"\n", file_name);
        return -1;
    }

    fprintf(file, "P3\n");
    fprintf(file, "%u %u\n", image->width, image->height);
    fprintf(file,"%u\n", image->max);

    int i,j;
    for (i = 0; i < image->height; i++)
    {
        for (j = 0; j < image->width; j++)
        {
            fprintf(file, "%u %u %u ", image->data[i][j].r, image->data[i][j].g,
image->data[i][j].b);
        }
        fprintf(file, "\n");
    }

    fclose(file);
    return 0;

}

void filter(Image *input, Image *output, int *kernel, int n, int scale){
#define KK(k,l)    kernel[(k) * n + (l)]
    int i,j,k,l;
```

```
int red, green, blue;
int x, y;
output->data = malloc(sizeof(Pixel*) * output->height);
for (i=0; i<output->height; i++){
	output->data[i] = malloc(sizeof(Pixel) * output->width);
}
i = 0;

while (i < input->height){
	j = 0;
	while (j < input->width)
	{
		red = 0;
		green = 0;
		blue = 0;
		k = 0;
		while (k < n)
		{
			l = 0;
			while (l < n)
			{
				x = i + k - (n/2);
				y = j + l - (n/2);

				if (x>=0 && x<input->height && y>=0 && y<input->width){
					red += ((int)((input->data)[x][y].r) * (KK(k,l))) / scale;
					green += ((int)((input->data)[x][y].g) * (KK(k,l))) / scale;
					blue += ((int)((input->data)[x][y].b) * (KK(k,l))) / scale;
				}
				else{
					red += 0;
					green += 0;
					blue += 0;
				}

				l++;
			}
			k++;
		}
		if (red < 0)
			red = 0;
		else if (red > 255)
			red = 255;
		if (green < 0)
```

```
                    green = 0;
                else if (green > 255)
                    green = 255;
                if (blue < 0)
                    blue = 0;
                else if (blue > 255)
                    blue = 255;
                output->data[i][j].r = (unsigned char)red;
                output->data[i][j].g = (unsigned char)green;
                output->data[i][j].b = (unsigned char)blue;

                j++;
            }
            i++;
        }
#undef KK
}

int main(int argc, char **argv){
    if (argc != 4){
        printf("Usage: ./filter input_pic.ppm kernel output_pic.ppm\n");
        return -1;
    }

    char * input = argv[1];
    if (!input) {
        printf("Can not open the input ppm file\n");
        return -1;
    }
    char * kernel = argv[2];
    if (!kernel) {
        printf("Can not open the Kernel file\n");
        return -1;
    }
    char * output = argv[3];
    if (!output){
        printf("Problem with the output ppm file\n");
        return -1;
    }
    FILE *f;
    f = fopen(kernel, "r");
    int size, scale;
    if(fscanf(f,"%d",&size)!= 1)
        return 0;
```

```
        if(fscanf(f,"%d",&scale) != 1)
                return 0;
        int * K = malloc(sizeof(int) * size * size);
        int i;
        for(i = size*size - 1; i >= 0; i--){
                if(fscanf(f, "%d", K+i) != 1){
                        return 0;
                }
        }
        fclose(f);
        Image *in_img = readPPM(input);
        Image *out_img =(Image*)malloc(sizeof(Image));
        out_img->width = in_img->width;
        out_img->height = in_img->height;
        out_img->max = in_img->max;
        filter(in_img,out_img,K,size,scale);
        writePPM(output,out_img);
        return 0;
}
```

makefile.f

```
CFLAGS=-Wall -O2 -ansi
filter: filter.o
        $(CXX) -o filter $?

clean :
        @rm -rf filter *.o *.ppm
```

Cities.c

```
#define   _CRT_SECURE_NO_WARNINGS
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <malloc.h>
typedef struct
{
        char * city;
        char * country;
        double population;
}City;

City cities[10005];
int cityn = 0;
```

```
int compare(const void * a, const void * b) {
	City * Ca = (City *)a;
	City * Cb = (City *)b;
	return Cb->population - Ca->population;
}
int main()
{
	FILE* fp = fopen("cities.csv", "r");
	char line[1005];
	int linen = 0;
	int i;
	while (fgets(line, 1005, fp))
	{
		if (line[strlen(line) - 1] == '\n')
			line[strlen(line) - 1] = '\0';
		if (linen > 0)
		{
			char delims[] = ",";
			char* result = NULL;
			char* record = NULL;
			record = strtok(line, ",");
			cities[cityn].city = (char*)malloc(sizeof(char) * 1005);
			strcpy(cities[cityn].city, record);
			record = strtok(NULL, ",");
			record = strtok(NULL, ",");
			record = strtok(NULL, ",");
			record = strtok(NULL, ",");
			cities[cityn].population = atof(record);
			record = strtok(NULL, ",");
			cities[cityn].country = (char*)malloc(sizeof(char) * 1005);
			strcpy(cities[cityn].country, record);
			cityn++;
		}
		linen++;
	}

	qsort(cities, cityn, sizeof(City), compare);
	fp = fopen("sorted.csv", "w");
	for (i = 0; i < cityn;i++)
	{
		fprintf(fp, "%s,%d,%s\n", cities[i].city, (int)cities[i].population, cities[i].country);
	}
	fclose(fp);
}
```