**Macros**

.macro displaymsg msg

#store

addi x10, x10, 0

addi sp, sp, -16

sw a4, 0(sp)

sw t3, 4(sp)

sw t5, 8(sp)

sw t6, 12(sp)

#program

li t6, 0x10000100 #address of UART for nexys a7

li t5, 0x10000114 #address of its status register

**print\_characters\_\@:**

lb a4, 0(\msg)

beqz a4, exit

sb a4, 0(t6)

**cont\_\@:**

lw t3, 0(t5) # Load UART status register

andi t3, t3, 0x20 # Check if it can print

beqz t3, **cont\_\@**

addi \msg, \msg, 1

j **print\_characters\_\@**

#loading

lw a4, 0(sp)

lw t3, 4(sp)

lw t5, 8(sp)

lw t6, 12(sp)

addi sp, sp, 16

.endm

.macro displaynum num, buffer

# This macro divides the number by 10 and stores the remainder in a buffer,

# effectively storing the number in reverse order which can then be converted to ASCII later

*#storing previous data in stack to be restored after program is finished*

addi x10, x10, 0

addi sp, sp, -28

sw t2, 0(sp)

sw t4, 4(sp)

sw t1, 8(sp)

sw t6, 12(sp)

sw t5, 16(sp)

sw a3, 20(sp)

sw a2, 24(sp)

#program

li t2, 10

addi \buffer, \buffer, 35 *# number can be 35 digits long*

mv t4, \buffer

**conversion\_\@:**

remu t1, \num, t2 *#Remainder after dividing by 10*

addi t1, t1, '0' *#adding ASCII value of 0, to convert said number to correct ASCII code*

addi \buffer, \buffer, -1 *#storing digit at the top of stack*

sb t1, 0(\buffer) *#storing the remainder*

divu \num, \num, t2 *#perform integer division by 10, to* move onto next number

bnez \num, **conversion\_\@ *#if it is 0 we have reached last digit***

**#**Adds space between numbers

addi t1, x0, 32 *#ASCII code for space at the very top of stack for good presentation*

addi \buffer, \buffer, -1

sb t1, 0(\buffer)

#Sends characters to display same procedure displaymsg

li t6, 0x10000100 *# Address of UART for nexys a7*

li t5, 0x10000114 *# Address of its status register*

**print\_\@:**

lb a3, (\buffer)

sb a3, 0(t6)

**can\_print\_\@:**

lw a2, 0(t5) *# Load UART status register*

andi a2, a2, 0x20 *# Check if it can print*

beqz a2, **can\_print\_\@** *# If not, wait*

addi \buffer, \buffer, 1 *# Move buffer pointer to next digit*

bne \buffer, t4, **print\_\@**

#loading back values stored in registers as program is finished executing

lw a2, 24(sp)

lw a3, 20(sp)

lw t5, 16(sp)

lw t6, 20(sp)

lw t1, 16(sp)

lw t4, 12(sp)

lw t2, 0(sp)

addi sp, sp, 28

.endm

.macro prime input, answer

#storing

Add x10, x10, x0

Add sp, sp, -16

Sw t1, 0(sp)

Sw t2, 4(sp)

Sw t3, 8(sp)

Sw t4, 12(sp)

li t1, 2 # setting it to 2

li t2, 3 # starting number for loop

bltz \input, not\_prime**\_\@** # check if negative

beq \input, t1, set\_prime**\_\@** # check if it is 2; if so jump to set\_prime to set \answer to 1

andi t3, \input, 1 # check if it is odd or even by checking the least significant bit

beq t3, x0, not\_prime**\_\@** # if even, it's not prime

Loop**\_\@**: # start a loop from 3

rem t4, \input, t2 # check if the number divided by the counter is remainder 0

beqz t4, not\_prime**\_\@** # jump to not\_prime if REM = 0 not prime

mul t4, t2, t2 # get counter squared

bgt t4, \input, set\_prime**\_\@** # check if the counter squared is above the limit

addi t2, t2, 2 # increment counter

j Loop**\_\@**

set\_prime**\_\@**: # set prime to 1

li \answer, 1

j end\_prime**\_\@**

not\_prime**\_\@**: # set not prime to 0

li \answer, 0

end\_prime**\_\@**:

#loading

lw t1 0(sp)

lw t2, 4(sp)

lw t3, 8(sp)

lw t3, 12(sp)

Add sp, sp, 16

.endm

**Resize jpegs - needs libjpeg-dev library, to install use *sudo apt-get libjpeg-dev***

//DOES NOT WORK ON REPL but does work after command

//sudo apt-get install libjpeg-dev in linux. this opens and edits the colour data of a jpeg. to resize it. I made the resize algorithm and mapped the colour data using linear interpolation. but the specifics to decompress and write to a jpeg was from chatgpt. I edited it to fit my program.

#include <stdio.h>

#include <jpeglib.h>

#include <stdlib.h>

*typedef struct {*

*unsigned char r, g, b;*

*} Pixel;*

*Pixel\*\* read\_jpeg\_file(const char\* filename, int\* width, int\* height) {*

*//surfs through header to get information and reach where pixel data is stored*

*struct jpeg\_decompress\_struct cinfo;*

*struct jpeg\_error\_mgr jerr;*

*FILE \*infile = fopen(filename, "rb");*

*if (!infile) {*

*printf("ERROR wrong/invalid file path %s\n", filename);*

*exit(0);*

*return 0;*

*}*

*cinfo.err = jpeg\_std\_error(&jerr);*

*jpeg\_create\_decompress(&cinfo);*

*jpeg\_stdio\_src(&cinfo, infile);*

*jpeg\_read\_header(&cinfo, TRUE);*

*jpeg\_start\_decompress(&cinfo);*

*\*width = cinfo.output\_width;*

*\*height = cinfo.output\_height;*

*//initialises 2d array of pixel structure to store colour information*

*Pixel\*\* image = (Pixel\*\*)malloc(cinfo.output\_height \* sizeof(Pixel\*));*

*for (int i = 0; i < cinfo.output\_height; i++) {*

*image[i] = (Pixel\*)malloc(cinfo.output\_width \* sizeof(Pixel));*

*}*

*JSAMPARRAY buffer = (\*cinfo.mem->alloc\_sarray)*

*((j\_common\_ptr) &cinfo, JPOOL\_IMAGE, cinfo.output\_width \* cinfo.output\_components, 1);*

*//loads colour data*

*while (cinfo.output\_scanline < cinfo.output\_height) {*

*jpeg\_read\_scanlines(&cinfo, buffer, 1);*

*for (int x = 0; x < cinfo.output\_width; x++) {*

*image[cinfo.output\_scanline-1][x].r = buffer[0][x \* cinfo.output\_components];*

*image[cinfo.output\_scanline-1][x].g = buffer[0][x \* cinfo.output\_components + 1];*

*image[cinfo.output\_scanline-1][x].b = buffer[0][x \* cinfo.output\_components + 2];*

*}*

*}*

*jpeg\_finish\_decompress(&cinfo);*

*jpeg\_destroy\_decompress(&cinfo);*

*fclose(infile);*

*return image;*

*}*

*void write\_file(const char\* filename, Pixel\*\* image, int width, int height){*

*struct jpeg\_compress\_struct cinfo;*

*struct jpeg\_error\_mgr jerr;*

*//writes data to header about image*

*FILE \*output = fopen(filename, "wb");*

*cinfo.err = jpeg\_std\_error(&jerr);*

*jpeg\_create\_compress(&cinfo);*

*jpeg\_stdio\_dest(&cinfo, output);*

*cinfo.image\_width = width;*

*cinfo.image\_height = height;*

*cinfo.input\_components = 3;*

*cinfo.in\_color\_space = JCS\_RGB;*

*jpeg\_set\_defaults(&cinfo);*

*jpeg\_start\_compress(&cinfo, TRUE);*

*JSAMPROW row\_pointer;*

*int row\_stride = width \* 3; // RGB channels*

*//writes colour*

*while (cinfo.next\_scanline < cinfo.image\_height) {*

*row\_pointer = (JSAMPROW) &image[cinfo.next\_scanline][0];*

*jpeg\_write\_scanlines(&cinfo, &row\_pointer, 1);*

*}*

*jpeg\_finish\_compress(&cinfo);*

*fclose(output);*

*jpeg\_destroy\_compress(&cinfo);*

*}*

int main() {

char filename[100]; // Allocate memory for filename

int x, y, ox, oy, owidth, oheight, nwidth, nheight;

float scaleh, scalew;

// Getting file path of the image

printf("Enter the file path of the image: ");

scanf("%s", filename);

Pixel\*\* image = read\_jpeg\_file(filename, &owidth, &oheight);

// Getting dimensions of the new image

printf("Enter the dimensions of the new image (height width): ");

scanf("%d %d", &nheight , &nwidth);

scaleh = (float) oheight / nheight;

scalew = (float) owidth / nwidth;

printf("%f %f\n", scaleh, scalew);

// Allocate memory for new\_image

Pixel\*\* new\_image = (Pixel\*\*) malloc(nheight \* sizeof(Pixel\*));

for (int i = 0; i < nheight; i++) {

new\_image[i] = (Pixel\*) malloc(nwidth \* sizeof(Pixel));

}

float oxf, oyf; // Used to check if we need to interpolate

f for (int y = 0; y < nheight; y++) {

for (int x = 0; x < nwidth; x++) {

oxf = scalew \* x;

oyf = scaleh \* y;

int ox = (int)oxf;

int oy = (int)oyf;

float fx = oxf - ox;

float fy = oyf - oy;

if (ox >= owidth - 1) ox = owidth - 2;

if (oy >= oheight - 1) oy = oheight - 2;

Pixel p1 = image[oy][ox];

Pixel p2 = image[oy][ox + 1];

Pixel p3 = image[oy + 1][ox];

Pixel p4 = image[oy + 1][ox + 1];

new\_image[y][x].r = (unsigned char)((1 - fx) \* (1 - fy) \* p1.r + fx \* (1 - fy) \* p2.r + (1 - fx) \* fy \* p3.r + fx \* fy \* p4.r);

new\_image[y][x].g = (unsigned char)((1 - fx) \* (1 - fy) \* p1.g + fx \* (1 - fy) \* p2.g + (1 - fx) \* fy \* p3.g + fx \* fy \* p4.g);

new\_image[y][x].b = (unsigned char)((1 - fx) \* (1 - fy) \* p1.b + fx \* (1 - fy) \* p2.b + (1 - fx) \* fy \* p3.b + fx \* fy \* p4.b);

}

}

// Write the scaled image to a new file

write\_file("scaled.jpg", new\_image, nwidth, nheight);

// Free memory allocated for both image and new\_image

for (int i = 0; i < oheight; i++) {

free(image[i]);

}

free(image);

for (int i = 0; i < nheight; i++) {

free(new\_image[i]);

}

free(new\_image);

return 0;

}

**Calculates coefficients of polynomial using only coordinates - repl finding coefficients(1) - C**

#include <stdio.h>

#include <stdlib.h>

#include <math.h>

// Function to allocate memory for a matrix

double\*\* allocateMatrix(int degree) {

double\*\* matrix = (double\*\*)malloc(degree \* sizeof(double\*));

for (int i = 0; i < degree; i++) {

matrix[i] = (double\*)malloc(degree \* sizeof(double));

}

return matrix;

}

void gaussElimination(double\*\* matrix, double\*\* inverse, int degree) {

for (int i = 0; i < degree; i++) { //to cycle through every row

double pivot = matrix[i][i]; //is the value in matrix, with the position where a 1 will be in identity matrix

if (pivot == 0) { //check if it is 0, as will use it to divide later

for (int k = i + 1; k < degree; k++) { //if it is 0, we trying to swap this row with the one below

if (matrix[k][i] != 0) {

for (int j = 0; j < degree; j++) {

double temp = matrix[i][j]; //swapping one element at a time in the row

matrix[i][j] = matrix[k][j];

matrix[k][j] = temp;

temp = inverse[i][j]; //copying the same action in indentity matrix

inverse[i][j] = inverse[k][j];

inverse[k][j] = temp;

}

pivot = matrix[i][i]; //updating pivot

break;

}

}

if (pivot == 0) { // if the pivot is still 0, then an inverse can't be calculated

printf("Matrix is singular and cannot be inverted\n");

return;

}

}

for (int j = 0; j < degree; j++) { //dividing every element in the row by the pivot, to make value at pivot position 1

matrix[i][j] /= pivot;

inverse[i][j] /= pivot;

}

for (int k = 0; k < degree; k++) { // we are subtracting pivot row from other rows, in an effort to make values in the same column as pivot = 0

if (k != i) {

double factor = matrix[k][i]; //setting value that we want to become 0

for (int j = 0; j < degree; j++) {

matrix[k][j] -= factor \* matrix[i][j]; //multiplying and subtracting to ensure the factor value turns to 0, but the others are still non-zero. factor becomes 0, because the value in pivot position is 1 from previous division which is selected in first iteration of j loop.

inverse[k][j] -= factor \* inverse[i][j];

}

}

}

}

}

int main() {

int degree;

double x;

printf("Enter the degree of the polynomial: ");

scanf("%d", &degree);

degree += 1;

//intialising matrices, as 2d arrays

double\*\* matrix = allocateMatrix(degree);

double\*\* inverse = allocateMatrix(degree);

//intialising vectors as 1d arrays

double\* y = (double\*)malloc(degree \* sizeof(double));

double\* result = (double\*)malloc(degree \* sizeof(double));

//gathering inputs

for (int i = 0; i < degree; i++) {

printf("Enter the coordinates:\n");

scanf("%lf %lf", &x, &y[i]);

for (int j = 0; j < degree; j++) {

matrix[i][(degree - 1) - j] = pow(x, j); //setting up matrix with X^n to X^0.

if (i == j) { //setting up inverse matrix

inverse[i][j] = 1.0;

} else {

inverse[i][j] = 0.0;

}

}

}

gaussElimination(matrix, inverse, degree);

//perform multiplication with vector by calculating the dot product between each row in the inverse matrix and the y coordinate vector

for (int i = 0; i < degree; i++){

for (int j = 0; j < degree; j++){

result[i] += inverse[i][j] \* y[j];

}

}

printf("The coefficients are: \n");

for (int i =0; i < degree; i++){

printf("%.2lf ", result[i]);

}

return 0;

}