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# 1 POSIX Threads

All of the running time of a programs are in appendix chapter (screenshots).

## 1.1 Password Cracking

a. Insert a table of 10 running times and the mean running time.

Calculating running times for the original program.	
	Time for original program.
1 <sup>st</sup>	852.086086160 Sec
2 <sup>nd</sup>	852.851117573 Sec
3 <sup>rd</sup>	866.621660790 Sec
4 <sup>th</sup>	841.839096854 Sec
5 <sup>th</sup>	870.891680057 Sec
6 <sup>th</sup>	825.242112556 Sec
7 <sup>th</sup>	864.673123279 Sec
8 <sup>th</sup>	877.859196113 Sec
9 <sup>th</sup>	871.069347481 Sec
10 <sup>th</sup>	854.746969314 Sec
Total time:	8577.88039018 Sec
Mean Time in sec:	857.788039018 Sec
Mean Time in Min :	14.296467317 Min

From above table, we know that the average time taken to crack password is 14.296467317 minute.

b. Insert a paragraph that hypothesis's how long it would take to run if the number of initials were to be increased to 3. Include your calculations.

3-initials-2digits Password Cracking Program.

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

*****  
*****
Demonstrates how to crack an encrypted password using a simple
"brute force" algorithm. Works on passwords that consist only of 2
uppercase
letters and a 2 digit integer. Your personalized data set is included
in the
code.
```

Compile with:

```
cc -o CrackAZ99-With-3initials CrackAZ99-With-3initials.c -lcrypt
```

If you want to analyse the results then use the redirection operator  
to send  
output to a file that you can view using an editor or the less  
utility:

```
./CrackAZ99-With-3initials > results.txt
```

```
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*****  
*****
int n_passwords = 4;

char *encrypted_passwords[] = {

"$6$KB$.0nsM0.pEomFoalYh1Tz0da3BPcVeBs6fn3fn6Aq8XMjLMc5aImRqL9hBnjFpCVLigSq9dYwA
e1FBufipopxY1",

"$6$KB$a3I0PZzxK72KmUEF9BwCDgavNTcKF7qMyisIX92DAGRCEiU4eAngEL7TSC/
v.vAix7d0j1jFV3stlwZUohpEo0",

"$6$KB$hn2ozvmpb8pvNu.G7pewcZb6xu.iQBuE9MywKWKPgsALV.gpJnzo8NQqJBs7yvs13jPV2dfic
oIfumz04V5uH/",

"$6$KB$o1ZCfk2QE6ENjSr9AViCaiPy6Ln1.pkNEorytYnS5gEAAk4dYSTUomM5YGbXSs6Zg10bJ3Hir
aiyI00NH1oAb0"
};

/**  
Required by lack of standard function in C.  
*/  
  
void substr(char *dest, char *src, int start, int length){
    memcpy(dest, src + start, length);
    *(dest + length) = '\0';
}
```

```

/**
This function can crack the kind of password explained above. All
combinations
that are tried are displayed and when the password is found, #, is put
at the
start of the line. Note that one of the most time consuming operations
that
it performs is the output of intermediate results, so performance
experiments
for this kind of program should not include this. i.e. comment out the
printfs.
*/

void crack(char *salt_and_encrypted){
    int w, x, y, z;      // Loop counters
    char salt[7];        // String used in hashing the password. Need space
    char plain[7];       // The combination of letters currently being checked
    char *enc;           // Pointer to the encrypted password
    int count = 0;        // The number of combinations explored so far

    substr(salt, salt_and_encrypted, 0, 6);

    for(w='A'; w<='Z'; w++){
        for(x='A'; x<='Z'; x++){
            for(y='A'; y<='Z'; y++){
                for(z=0; z<=99; z++){
                    sprintf(plain, "%c%c%c%02d", w, x, y, z);
                    enc = (char *) crypt(plain, salt);
                    count++;
                    if(strcmp(salt_and_encrypted, enc) == 0){
                        printf("#%-8d%s %s\n", count, plain, enc);
                    } else {
                        printf(" %-8d%s %s\n", count, plain, enc);
                    }
                }
            }
        }
    }
    printf("%d solutions explored\n", count);
}

// Calculate the difference between two times. Returns zero on
// success and the time difference through an argument. It will
// be unsuccessful if the start time is after the end time.

int time_difference(struct timespec *start,
                     struct timespec *finish,
                     long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
    *difference = ds * 1000000000 + dn;
    return !(*difference > 0);
}

```

```

int main(int argc, char *argv[]){
    int i;
    struct timespec start, finish;
    long long int time_elapsed;

    clock_gettime(CLOCK_MONOTONIC, &start);

    for(i=0;i<n_passwords;i<i++) {
        crack(encrypted_passwords[i]);
    }

    clock_gettime(CLOCK_MONOTONIC, &finish);
    time_difference(&start, &finish, &time_elapsed);
    printf("Time elapsed was %lldns or %0.9lfms or %0.9lfmin\n", time_elapsed,
           (time_elapsed/1.0e9),
           ((time_elapsed/1.0e9)/60));

    return 0;
}

*****

```

Ans:

From 2 initial number program we know that, it took approximately 14.296 minute time to run program. So, if we increase the number of initials to 3, which means (A-Z) = 26 character, then the time should increase by  $26 * 14.296 = 371.696$  min = 6.1949 hours.

c. Explain your results of running your 3 initial password cracker with relation to your earlier hypothesis.

Ans:

From above (question number b) estimation it was found that it should take 6.1949 hours to run 3 initial password cracking program but actually it took 337.457580566 min = 5.624293009 hours  $\approx$  6 hours. Because of good processor of laptop.

## Multi-thread Password Cracking Program.

```
#include <stdlib.h>
#include <stdio.h>
#include <ctype.h>
#include <sys/stat.h>
#include <string.h>
#include <time.h>
#include <pthread.h>
#include <crypt.h>
*****
***** Demonstrates how to crack an encrypted password using a simple
"brute force" algorithm. Works on passwords that consist only of 2
uppercase
letters and a 2 digit integer. Your personalised data set is included
in the
code.

Compile with:
cc -o CrackAZ99-With-Data-multi-threads CrackAZ99-With-Data-multi-threads.c -
lcrypt -pthread

If you want to analyse the results then use the redirection operator
to send
output to a file that you can view using an editor or the less
utility:

./CrackAZ99-With-Data-multi-threads > results.txt

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*****
****/

int n_passwords = 4;

char *encrypted_passwords[] = {

    "$6$KB$6SsUGf4Cq7/Oooym9WWQN3VKeo2lynKV9gXVyEG4HvYy1UFRx.XAye89TLp/
OTcW7cGpf9UlU0F.ck/S9CfZn1",
    "$6$KB$1vCJQRsKAizzVuTjEqLE./
zeAqZ7AdqzTdx5Tob.bQDRG1X0EVkNhuqMorBSvCp4fP0eoNm2wULs3DRABbrLQ/",
    "$6$KB$VKxGV/w3/
XgUswkstexjD72Q5jKKSTyxSfIqlkwtApaQlnYvPfZA4038d1fc4QvWxDc93T4Hzff/ksMKgfzFM/",
    "$6$KB$xJHmCu7jpWBZlq2AAXZUB5ZF8NCJgZkydHbCyfPwy3nE.djIlSmUxHDLAZdnwz8ys5L8L9.61
NMdYXsyN32r11"
};

/***
Required by lack of standard function in C.
***/

void substr(char *dest, char *src, int start, int length){
    memcpy(dest, src + start, length);
    *(dest + length) = '\0';
}
```

```

}

/*
This function can crack the kind of password explained above. All
combinations
that are tried are displayed and when the password is found, #, is put
at the
start of the line. Note that one of the most time consuming operations
that
it performs is the output of intermediate results, so performance
experiments
for this kind of program should not include this. i.e. comment out the
printfs.
*/

void crack_block() {
    int i;
    pthread_t thread_1, thread_2;

    void *kernel_function_1();
    void *kernel_function_2();

    for(i=0;i<n_passwords;i<i++) {
        pthread_create(&thread_1, NULL, kernel_function_1, encrypted_passwords[i] );
        pthread_create(&thread_2, NULL, kernel_function_2, encrypted_passwords[i]);

        pthread_join(thread_1, NULL);
        pthread_join(thread_2, NULL);
    }
}

void *kernel_function_1(char *salt_and_encrypted){
    int x, y, z;          // Loop counters
    char salt[7];         // String used in hashing the password. Need space
    char plain[7];        // The combination of letters currently being checked
    char *enc;            // Pointer to the encrypted password
    int count = 0;         // The number of combinations explored so far

    substr(salt, salt_and_encrypted, 0, 6);

    for(x='A'; x<='M'; x++){
        for(y='A'; y<='Z'; y++){
            for(z=0; z<=99; z++){
                sprintf(plain, "%c%c%02d", x, y, z);
                enc = (char *) crypt(plain, salt);
                count++;
                if(strcmp(salt_and_encrypted, enc) == 0){
                    printf("#%-8d%s %s\n", count, plain, enc);
                } else {
                    printf(" %-8d%s %s\n", count, plain, enc);
                }
            }
        }
    }
}

void *kernel_function_2(char *salt_and_encrypted){
    int x, y, z;          // Loop counters

```

```

char salt[7];      // String used in hashing the password. Need space
char plain[7];    // The combination of letters currently being checked
char *enc;         // Pointer to the encrypted password
int count = 0;     // The number of combinations explored so far

substr(salt, salt_and_encrypted, 0, 6);

for(x='N'; x<='Z'; x++){
    for(y='A'; y<='Z'; y++){
        for(z=0; z<=99; z++){
            sprintf(plain, "%c%c%02d", x, y, z);
            enc = (char *) crypt(plain, salt);
            count++;
            if(strcmp(salt_and_encrypted, enc) == 0){
                printf("#%-8d %s\n", count, plain, enc);
            } else {
                printf(" %-8d %s\n", count, plain, enc);
            }
        }
    }
}
printf("%d solutions explored\n", count);

int time_difference(struct timespec *start, struct timespec *finish,
                     long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
    *difference = ds * 1000000000 + dn;
    return !(*difference > 0);
}

int main(int argc, char *argv[]) {
    struct timespec start, finish;
    long long int time_elapsed;

    clock_gettime(CLOCK_MONOTONIC, &start);

    crack_block();

    clock_gettime(CLOCK_MONOTONIC, &finish);
    time_difference(&start, &finish, &time_elapsed);
    printf("Time elapsed was %lldns or %0.9lfs or %0.9lfmin\n",
           time_elapsed,
           (time_elapsed/1.0e9),
           ((time_elapsed/1.0e9)/60));

    return 0;
}

*****

```

d. Write a paragraph that compares the original results with those of your multi-thread password cracker.

Calculating running times for the original program and for multi-thread version.		
	Time for original program.	Time for multi-thread program.
1 <sup>st</sup>	852.086086160 Sec	424.101145135 Sec
2 <sup>nd</sup>	852.851117573 Sec	428.928177644 Sec
3 <sup>rd</sup>	866.621660790 Sec	428.028800344 Sec
4 <sup>th</sup>	841.839096854 Sec	426.398617337 Sec
5 <sup>th</sup>	870.891680057 Sec	432.247245291 Sec
6 <sup>th</sup>	825.242112556 Sec	430.344344965 Sec
7 <sup>th</sup>	864.673123279 Sec	430.50855403 Sec
8 <sup>th</sup>	877.859196113 Sec	431.871656769 Sec
9 <sup>th</sup>	871.069347481 Sec	433.916258052 Sec
10 <sup>th</sup>	854.746969314 Sec	475.311364531 Sec
Total time:	8577.88039018 Sec	4341.656164098 Sec
Mean Time in sec:	857.788039018 Sec	434.1656164098 Sec
Mean Time in Min :	14.296467317 Min	7.23609360683 Min

From above table, we know that the average time taken to crack password by using multi-threading is 7.2360 minute. So, we can say that by using multi-thread in password cracking can reduce time by half or more according to the processor of laptop or desktop.

These password was found from Password Cracking.

```
ashishshrestha@ashishshrestha:~/Documents/Assignment$ ./CrackAZ99-With-Data-multi-threads | grep '#'
#7379  CV78 $6$KB$6SsUGf4Cq7/0ooym9WQn3VKeo2lynKVgXVYEG4HvYy1UFRx.XAye89TLp/0TcW7cGpf9ULU0F.cK/S9CfZn1
#14988 FT87 $6$KB$1vCJQRsKAizZvuTjEqLE./zeAqZ7AdqzTdx5Tob.bQDRGlX0EVkNhuqMorBSvCp4fP0eoNm2wULs3DRABbrLQ/
#17377 GR76 $6$KB$VKxGV/w3/XgUswkstexjD72Q5jKKSTyxSfI0lkwtApaQlnYvPfZA4038d1fc4QvWxDc93T4Hzff/ksMKgfzFM/
#13065 SA64 $6$KB$xJHmCu7jpWBZlq2AAZUB5ZF8NcJgZkydHbCyfPwy3nE.djI1SmUxHDLAZdnwz8ys5L8L9.61NMdYXsyN32r11
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 
```

## 1.2 Image Processing

a. Insert the image displayed by your program

Image obtained by running a given program.



Image Processing program using multi-threaded edge detector.

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <GL/glut.h>
#include <GL/glu.h>
#include <malloc.h>
#include <signal.h>
#include <pthread.h>
*****
Displays two grey scale images. On the left is an image that has come from an
image processing pipeline, just after colour thresholding. On the right is
the result of applying an edge detection convolution operator to the left
image. This program performs that convolution.
```

Things to note:

- A single unsigned char stores a pixel intensity value. 0 is black, 256 is white.
- The colour mode used is GL\_LUMINANCE. This uses a single number to represent a pixel's intensity. In this case we want 256 shades of grey, which is best stored in eight bits, so GL\_UNSIGNED\_BYTE is specified as the pixel data type.

To compile adapt the code below wo match your filenames:

```
cc -o ip_coursework_multi_thread_014 ip_coursework_multi_thread_014.c -lglut -lGL -lm -pthread
```

To run this program:

```
./ip_coursework_multi_thread_014
```

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```
*****
```

```
#define width 100
#define height 72
```

```
unsigned char image[], results[width * height];
typedef struct arguments_t {
    int start;
    int stride;
```

```

unsigned char *input;
unsigned char *output;
} arguments_t;

void edge_detect(unsigned char *image, unsigned char *results) {
    pthread_t th1, th2, th3, th4;

    arguments_t t1_arguments;
    t1_arguments.start = 0;
    t1_arguments.stride = 4;
    t1_arguments.input = image;
    t1_arguments.output = results;

    arguments_t t2_arguments;
    t2_arguments.start = 1;
    t2_arguments.stride = 4;
    t2_arguments.input = image;
    t2_arguments.output = results;

    arguments_t t3_arguments;
    t3_arguments.start = 2;
    t3_arguments.stride = 4;
    t3_arguments.input = image;
    t3_arguments.output = results;

    arguments_t t4_arguments;
    t4_arguments.start = 3;
    t4_arguments.stride = 4;
    t4_arguments.input = image;
    t4_arguments.output = results;

    void *detect_image_edges();

    pthread_create(&th1, NULL, detect_image_edges, &t1_arguments);
    pthread_create(&th2, NULL, detect_image_edges, &t2_arguments);
    pthread_create(&th3, NULL, detect_image_edges, &t3_arguments);
    pthread_create(&th4, NULL, detect_image_edges, &t4_arguments);

    pthread_join(th1, NULL);
    pthread_join(th2, NULL);
    pthread_join(th3, NULL);
    pthread_join(th4, NULL);
}

void *detect_image_edges(arguments_t *args) {
    int i;
    int n_pixels = width * height;
    unsigned char *in = args->input;
    unsigned char *out = args->output;

    for(i = args->start; i < n_pixels; i += args->stride) {
        int x, y; // the pixel of interest
        int b, d, f, h; // the pixels adjacent to x,y used for the calculation
        int r; // the result of calculate

        y = i / width;
        x = i - (width * y);
    }
}

```

```

if (x == 0 || y == 0 || x == width - 1 || y == height - 1) {
    results[i] = 0;
} else {
    b = i + width;
    d = i - 1;
    f = i + 1;
    h = i - width;

    r = (in[i] * 4) + (in[b] * -1) + (in[d] * -1) + (in[f] * -1)
        + (in[h] * -1);

    if (r > 0) { // if the result is positive this is an edge pixel
        out[i] = 255;
    } else {
        out[i] = 0;
    }
}
}

void tidy_and_exit() {
    exit(0);
}

void sigint_callback(int signal_number){
    printf("\nInterrupt from keyboard\n");
    tidy_and_exit();
}

static void display() {
    glClear(GL_COLOR_BUFFER_BIT);
    glRasterPos4i(-1, -1, 0, 1);
    glDrawPixels(width, height, GL_LUMINANCE, GL_UNSIGNED_BYTE, image);
    glRasterPos4i(0, -1, 0, 1);
    glDrawPixels(width, height, GL_LUMINANCE, GL_UNSIGNED_BYTE, results);
    glFlush();
}

static void key_pressed(unsigned char key, int x, int y) {
    switch(key){
        case 27: // escape
            tidy_and_exit();
            break;
        default:
            printf("\nPress escape to exit\n");
            break;
    }
}

int time_difference(struct timespec *start, struct timespec *finish,
                    long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
}

```















```

0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,255,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
};

 *****/

```

b. Insert a table that has columns containing running times for the original program and your multi-thread version. Mean running times should be included at the bottom of the columns.

Calculating running times for the original program and for multi-thread version.		
	Time for original program in second.	Time for multi-thread program in second.
1 <sup>st</sup>	0.000244189	0.000276838
2 <sup>nd</sup>	0.000158769	0.000386129
3 <sup>rd</sup>	0.000134126	0.000563675
4 <sup>th</sup>	0.000124196	0.000390902
5 <sup>th</sup>	0.000320527	0.000624942
6 <sup>th</sup>	0.000182322	0.00058715
7 <sup>th</sup>	0.000297749	0.000371939
8 <sup>th</sup>	0.000330665	0.000629257
9 <sup>th</sup>	0.000338829	0.000600857
10 <sup>th</sup>	0.000286728	0.000544998
Total time:	0.0024181	0.004976687
Mean Time:	0.00024181	0.0004976687

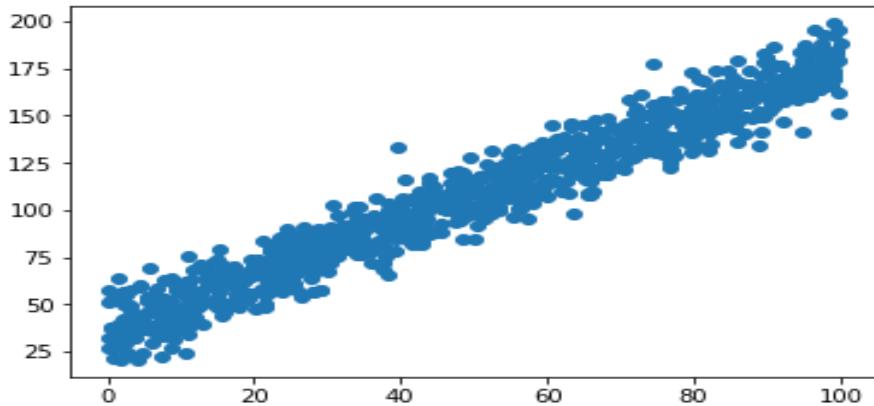
c. Insert an explanation of the results presented in the above table.

Ans:

From above table the mean time to run an original program is 0.00024181 sec and for multi-thread program mean time is 0.0004976687 sec. Which shows that the multi-thread program took more time to execute compared to original program because in multi-thread program there are four pixels in parallel which processes each thread. So, it took more time.

## 1.3 Linear Regression

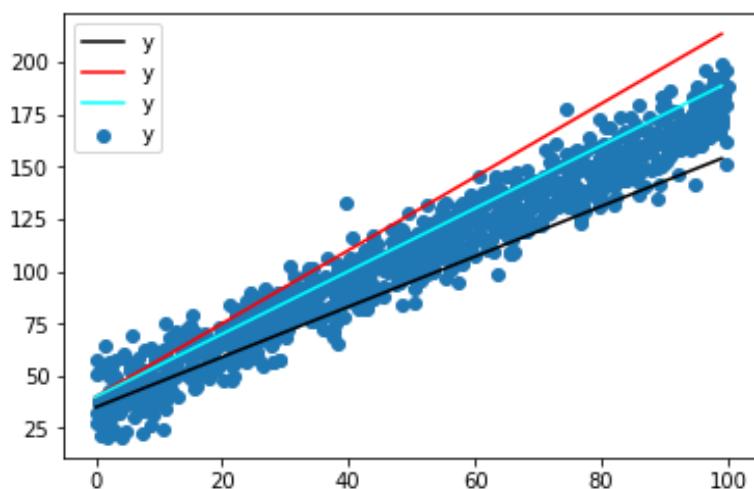
a. Insert a scatter plot of your data.



b. Have 3 guesses at the optimum values for m and c and present them in a graph that overlays your data.

The three initial guesses are:

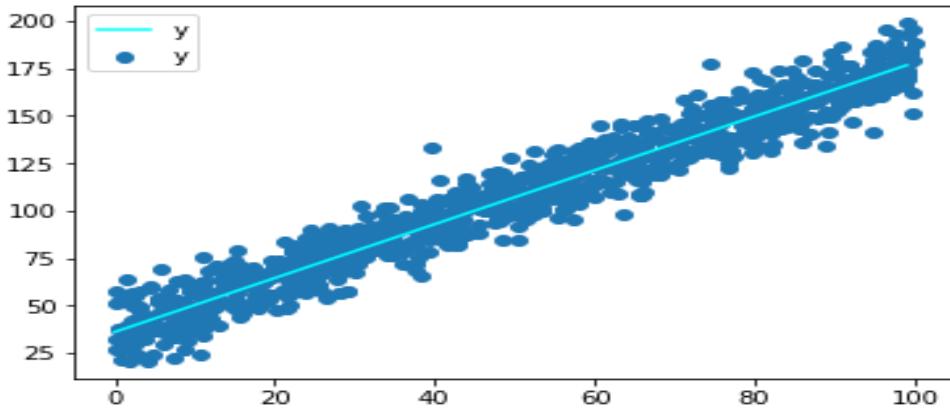
- i.  $m = 1.2, c = 35$
- ii.  $m = 1.75, c = 40$
- iii.  $m = 1.5, c = 40$



c. Insert a graph that presents your data with the solution overlaid.

My data, obtained from running original program.

```
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 153750012ns or 0.153750012s
m = 1.42 , c = 36.18
```



d. Insert a comment that compares your guesses with the solution found.

Ans:

My guesses are ,

- i.  $m = 1.2 , c = 35$
- ii.  $m = 1.75 , c = 40$
- iii.  $m = 1.5 , c = 40$

But the actual slope ( $m$ ) and intercept ( $c$ ) is  $m = 1.42 , c = 36.18$ , which is nearly to my second guess.

Linear Regression multi-thread program.

```
#include <stdio.h>
#include <math.h>
#include <pthread.h>

/**********************************************************
* This program takes an initial estimate of m and c and finds the associated
* rms error. It is then used as a base to generate and evaluate 8 new estimates,
* which are steps in different directions in m-c space. The best estimate is
* then used as the base for another iteration of "generate and evaluate". This
* continues until none of the new estimates are better than the base. This is
* a gradient search for a minimum in mc-space by using thread.
*
* To compile:
*   cc -o lr_coursework_multi-thread 'lr_coursework _multi-thread.c' -lm -
pthread
*
* To run:
*   ./lr_coursework_multi-thread
*
* Dr Kevan Buckley, University of Wolverhampton, 2018
**********************************************************/

typedef struct point_t {
    double x;
    double y;
} point_t;

int n_data = 1000;
point_t data[];

double residual_error(double x, double y, double m, double c) {
    double e = (m * x) + c - y;
    return e * e;
}

double bm = 1.3;
double bc = 10;
double be;
double dm[8];
double dc[8];
double e[8];
double step = 0.01;
double best_error = 999999999;
int best_error_i;
int minimum_found = 0;

double om[] = {0,1,1, 1, 0,-1,-1,-1};
double oc[] = {1,1,0,-1,-1, 0, 1};

double rms_error(double m, double c) {
    int i;
    double mean;
    double error_sum = 0;

    for(i=0; i<n_data; i++) {
        error_sum += residual_error(data[i].x, data[i].y, m, c);
    }
    mean = error_sum / n_data;
    error_sum = 0;
    for(i=0; i<n_data; i++) {
        error_sum += residual_error(data[i].x, data[i].y, m, c);
    }
    error_sum = error_sum / n_data;
    if(error_sum < best_error) {
        best_error = error_sum;
        best_error_i = i;
        m = om[i];
        c = oc[i];
        minimum_found = 1;
    }
}
```

```

}

mean = error_sum / n_data;

return sqrt(mean);
}

void *kernel_threads_function(void *args){
    int *arg = args;
    int i = *arg;
    dm[i] = bm + (om[i] * step);
    dc[i] = bc + (oc[i] * step);

    e[i] = rms_error(dm[i], dc[i]);

    if(e[i] < best_error) {
        best_error = e[i];
        best_error_i = i;
        pthread_exit(NULL);
    }
}

int time_difference(struct timespec *start,
                     struct timespec *finish,
                     long long int *difference) {
long long int ds = finish->tv_sec - start->tv_sec;
long long int dn = finish->tv_nsec - start->tv_nsec;

if(dn < 0 ) {
    ds--;
    dn += 1000000000;
}
*difference = ds * 1000000000 + dn;
return !(*difference > 0);
}

int main() {
    int i;
    pthread_t th[8];

    be = rms_error(bm, bc);

    struct timespec start, finish;
    long long int time_elapsed;

    clock_gettime(CLOCK_MONOTONIC, &start);

    while(!minimum_found) {
        for(i=0;i<8;i++) {
            pthread_create(&th[i], NULL, (void*)kernel_threads_function , &i);
            pthread_join(th[i],NULL);
        }

        /*printf("best m,c is %lf,%lf with error %lf in direction %d\n",
        dm[best_error_i], dc[best_error_i], best_error, best_error_i);*/
        if(best_error < be) {
            be = best_error;
            bm = dm[best_error_i];
        }
    }
}

```

```

        bc = dc[best_error_i];
    } else {
        minimum_found = 1;
    }
}

printf("minimum m,c is %lf,%lf with error %lf\n", bm, bc, be);

clock_gettime(CLOCK_MONOTONIC, &finish);
time_difference(&start, &finish, &time_elapsed);
printf("Time elapsed was %lldns or %0.9lfs\n", time_elapsed,
       (time_elapsed/1.0e9));

return 0;
}

point_t data[] = {
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 {98.97, 198.88}, {85.91, 179.15}, {95.38, 169.13}, {85.64, 160.16},  
 {56.06, 100.60}, {96.89, 176.63}, {83.93, 150.17}, {48.80, 111.06},  
 {22.27, 79.22}, {95.58, 173.58}, {56.49, 124.20}, {92.03, 146.39},  
 {66.49, 131.04}, {39.22, 90.96}, {17.98, 48.44}, { 1.00, 33.27},  
 {80.50, 169.11}, {82.88, 173.50}, {57.92, 111.58}, {68.90, 130.96},  
 {38.65, 87.82}, {20.49, 73.50}, {58.10, 106.58}, {38.99, 88.07},  
 {41.65, 91.96}, {82.00, 140.65}, {33.81, 91.57}, {23.62, 78.38},  
 {75.76, 151.93}, {40.42, 116.08}, {30.84, 84.99}, {76.73, 148.69},  
 { 7.81, 62.57}, {66.31, 134.40}, {70.76, 143.33}, {16.91, 60.19},  
 { 8.16, 44.28}, {72.52, 138.18}, {28.13, 66.46}, {70.97, 126.90},  
 {54.46, 112.39}, {61.94, 110.06}, {45.47, 92.99}, {90.78, 156.57},  
 {66.08, 109.59}, {12.35, 56.66}, {17.23, 52.58}, {71.21, 158.27},  
 {61.22, 122.83}, {50.62, 117.43}, {26.52, 54.24}, {57.46, 126.25},  
 {28.74, 90.15}, {10.49, 48.72}, {62.11, 138.78}, {79.20, 140.57},  
 {73.06, 141.61}, {19.01, 52.29}, {15.35, 51.63}, {98.03, 174.79},  
 {19.43, 73.68}, {57.18, 95.12}, {28.71, 84.43}, {56.17, 114.52},  
 {12.66, 50.03}, {35.83, 78.66}, {73.95, 137.25}, {96.68, 169.26},  
 {13.12, 70.59}, {72.84, 142.80}, {80.36, 150.96}, {29.96, 67.92},  
 {41.51, 98.54}, {51.54, 102.60}, {81.96, 131.69}, {74.14, 138.07},  
 {10.89, 57.54}, {68.18, 127.68}, { 2.46, 49.79}, {51.99, 119.32},  
 {11.65, 55.78}, {75.74, 132.46}, {80.32, 146.13}, {96.60, 165.24},  
 {66.52, 147.54}, {18.28, 66.38}, {66.88, 138.55}, {66.37, 141.96},  
 {94.67, 179.38}, {56.35, 108.03}, {74.57, 130.64}, {59.22, 113.97},  
 {52.15, 104.28}, {46.60, 107.63}, {60.24, 126.30}, {75.58, 129.28},  
 {47.49, 100.09}, {96.21, 162.75}, {20.45, 68.77}, {39.10, 94.83},  
 {29.27, 76.85}, { 8.94, 36.23}, {97.54, 167.51}, {13.40, 64.23},  
 {26.77, 72.87}, {85.95, 157.69}, {11.91, 43.38}, {65.80, 107.86},  
 {41.47, 89.57}, {77.07, 131.29}, { 2.25, 41.23}, {21.29, 83.85},  
 {97.15, 164.38}, {33.93, 89.39}, {90.07, 158.68}, { 1.90, 32.41},  
 {59.48, 126.95}, {18.54, 62.78}, {36.23, 97.52}, {86.61, 160.14},  
 {28.96, 57.15}, {15.98, 67.67}, {58.71, 127.68}, {45.96, 105.75},

```

{90.77,155.07},{72.45,143.70},{40.83,85.07},{40.26,94.81},
{ 7.74,52.45},{42.50,102.66},{ 6.20,30.04},{40.97,97.68},
{57.38,131.11},{81.44,168.91},{ 2.14,42.62},{47.76,106.77},
{82.71,158.27},{97.74,181.81},{57.87,122.41},{99.50,182.94},
{77.02,151.94},{39.36,86.25},{ 2.21,56.76},{55.28,132.20},
{74.87,132.06},{42.57,109.85},{10.54,46.27},{68.74,123.83},
{99.98,188.43},{35.14,89.08},{79.73,145.31},{95.77,160.03},
{81.03,147.97},{26.37,71.29},{97.06,185.07},{90.27,164.86},
{84.43,162.64},{77.12,138.46},{78.68,141.56},{60.29,129.14},
{11.58,45.54},{47.52,115.01},{50.02,113.78},{95.50,184.29},
{43.90,87.31},{50.31,92.19},{57.40,110.42},{41.27,95.48},
{52.73,122.70},{97.37,181.72},{87.18,156.97},{ 0.27,27.24},
{32.53,78.79},{94.39,163.45},{29.47,74.81},{20.24,73.08},
{ 4.56,59.03},{38.65,90.42},{63.17,145.59},{12.77,49.40},
{14.36,72.37},{71.92,127.46},{35.96,72.29},{54.82,105.88},
{30.31,90.56},{70.58,121.99},{46.53,104.57},{83.62,164.66},
{10.50,43.60},{27.90,68.17},{46.54,100.24},{48.49,115.46},
{53.57,109.34},{19.56,55.62},{81.20,152.35},{55.46,96.62},
{94.19,158.45},{56.27,124.61},{80.51,146.14},{67.37,141.02},
{31.71,89.49},{93.04,161.28},{42.11,91.72},{33.56,93.79},
{ 4.44,60.08},{ 8.21,47.86},{90.51,177.18},{27.26,73.60},
{29.63,85.02},{52.43,112.75},{73.07,130.27},{ 1.79,20.71},
{28.08,81.49},{51.24,117.62},{47.53,109.75},{79.66,172.71},
{15.43,51.60},{39.10,78.55},{48.00,114.36},{ 2.19,39.04},
{16.43,49.62},{47.88,102.29},{24.64,68.34},{57.88,127.64},
{34.97,95.54},{ 4.03,42.88},{10.94,60.98},{36.51,105.88},
{74.16,142.76},{25.29,69.47},{59.63,112.76},{ 2.42,39.41},
{61.17,115.63},{ 0.02,57.34},{82.24,158.82},{84.95,156.06},
{38.16,65.51},{29.66,89.43},{84.26,144.66},{37.30,90.54},
{47.88,108.10},{99.07,171.56},{ 5.35,46.07},{91.88,159.90},
{66.92,118.74},{51.63,104.98},{86.92,149.65},{91.78,168.41}
};

//****************************************************************************

```

e. Insert a table that shows running times for the original and multi-thread versions.

Calculating running times for the original program and for multi-thread version.		
	Time for original program in second.	Time for multi-thread program in second.
1 <sup>st</sup>	0.153255700	0.729684644
2 <sup>nd</sup>	0.154264022	0.730370932
3 <sup>rd</sup>	0.153620850	0.729603310
4 <sup>th</sup>	0.155420145	0.739406606
5 <sup>th</sup>	0.152466764	0.720501911
6 <sup>th</sup>	0.150451341	0.730797864
7 <sup>th</sup>	0.155607034	0.731083206
8 <sup>th</sup>	0.151813714	0.712123609
9 <sup>th</sup>	0.153453562	0.744400154
10 <sup>th</sup>	0.153750012	0.707047138
Total time:	1.534103144	7.275019374
Mean Time:	0.1534103144	0.7275019374

From above table the mean time to run an original program is 0.1534103144 sec and for multi-thread program mean time is 0.7275019374 sec. Which shows that the multi-thread program took more time to execute compared to original program because in multi-thread program each of the evaluations i.e. eight values for m and c, performs on a different thread. So, it took more time than the original one.

## 2 CUDA

### 2.1 Password Cracking

CUDA based Password Cracking program.

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

*****
**

Compile with:
nvcc -o CrackAZ99-With-Data-cuda CrackAZ99-With-Data-cuda.cu

To run program:
./CrackAZ99-With-Data-cuda

Dr Kevan Buckley, University of Wolverhampton, 2018
*****
****

/*****
This function returns 1 if the attempt at cracking the password is
identical to the plain text password string stored in the program.
Otherwise, it returns 0.
*****/



__device__ int is_a_match(char *attempt) {
    char plain_pwd[] = "ML4249";
    char plain_pwd1[] = "PE3462";
    char plain_pwd2[] = "UM4598";
    char plain_pwd3[] = "GT9859";

    char *a = attempt;
    char *p = plain_pwd;
    char *q = plain_pwd1;
    char *r = plain_pwd2;
    char *s = plain_pwd3;

    while(*a == *p) {
        if(*a == '\0') {
            return 1;
        }
        a++;
        p++;
    }

    while(*a == *q) {
        if(*a == '\0') {
            return 1;
        }
    }
}
```

```

    a++;
    q++;
}

while(*a == *r) {
    if(*a == '\0') {
        return 1;
    }
    a++;
    r++;
}

while(*a == *s) {
    if(*a == '\0') {
        return 1;
    }
    a++;
    s++;
}

return 0;
}

*****  

The kernel function run in 675 threads uses  

nested loops to generate all possible passwords and test whether they match  

the hidden password.  

*****

```

```

__global__ void crack() {
    char alpha[26]=
{'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K', 'L', 'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T',
 'U', 'V', 'W', 'X', 'Y', 'Z'};

    char num[10] = {'0', '1', '2', '3', '4', '5', '6', '7', '8', '9'};

    char result[7];
    result[6] = '\0';
    int e, f, g, h;
    for(e=0;e<=9;e++) {
        for(f=0; f<=9; f++) {
            for(g=0; g<=9; g++) {
                for(h=0; h<=9; h++) {
                    result[0] = alpha[blockIdx.x];
                    result[1] = alpha[threadIdx.x];
                    result[2] = num[e];
                    result[3] = num[f];
                    result[4] = num[g];
                    result[5] = num[h];
                    if(is_a_match(result)) {
                        printf("password found: %s\n", result);
                    } else {
                        //printf("tried: %s\n", result);
                    }
                }
            }
        }
    }
}

```

```

    }
}

}

int time_difference(struct timespec *start, struct timespec *finish,
                     long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
    *difference = ds * 1000000000 + dn;
    return !(*difference > 0);
}

int main(int argc, char *argv[]) {
    struct timespec start, finish
;
    long long int time_elapsed;

    clock_gettime(CLOCK_MONOTONIC, &start);

    crack <<<26, 26>>>();
    cudaThreadSynchronize();

    clock_gettime(CLOCK_MONOTONIC, &finish);
    time_difference(&start, &finish, &time_elapsed);
    printf("Time elapsed was %lldns or %0.9lfs\n", time_elapsed,
           (time_elapsed/1.0e9));

    return 0;
}

/*****************************************/

```

a. Insert a table that shows running times for the original, multi-thread and CUDA versions.

Calculating running times for the original program, multi-thread version and CUDA version.			
S.NO.	Time for original program.	Time for multi-thread program.	Time for CUDA program.
1 <sup>st</sup>	852.086086160 Sec	424.101145135 Sec	0.109940907 Sec
2 <sup>nd</sup>	852.851117573 Sec	428.928177644 Sec	0.103769861 Sec
3 <sup>rd</sup>	866.621660790 Sec	428.028800344 Sec	0.103947175 Sec
4 <sup>th</sup>	841.839096854 Sec	426.398617337 Sec	0.106515338 Sec
5 <sup>th</sup>	870.891680057 Sec	432.247245291 Sec	0.111379871 Sec
6 <sup>th</sup>	825.242112556 Sec	430.344344965 Sec	0.107143562 Sec
7 <sup>th</sup>	864.673123279 Sec	430.50855403 Sec	0.111375666 Sec
8 <sup>th</sup>	877.859196113 Sec	431.871656769 Sec	0.110901209 Sec
9 <sup>th</sup>	871.069347481 Sec	433.916258052 Sec	0.109263462 Sec
10 <sup>th</sup>	854.746969314 Sec	475.311364531 Sec	0.115912735 Sec
Total time:	8577.88039018 Sec	4341.656164098 Sec	1.090149786 Sec
Mean Time in sec:	857.788039018 Sec	434.1656164098 Sec	0.1090149786 Sec
Mean Time in Min :	14.296467317 Min	7.23609360683 Min	0.00181691631 Min

b. Write a short analysis of the results

Ans:

From above table the mean time to run an original program is 14.296467317 Min and for multi-thread program mean time is 7.23609360683 Min and for CUDA program mean time is 0.1090149786 Sec or 0.00181691631 Min. CUDA version password cracking is faster than other two program because in CUDA password cracking program we give hardcore password rather than encrypted password because NVIDIA graphic does not support encryption and it also runs parallel over 675 threads. So, it is fastest among other two program.

The hardcore passwords are:

```

password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 109940907ns or 0.109940907s

```

## 2.2 Image Processing

## CUDA based image processing program.

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <GL/glut.h>
#include <GL/gl.h>
#include <malloc.h>
#include <signal.h>
#include <cuda_runtime_api.h>
*****
Displays two grey scale images. On the left is an image that has come from an
image processing pipeline, just after colour thresholding. On the right is
the result of applying an edge detection convolution operator to the left
image. This program performs that convolution.
```

## Things to note:

- A single unsigned char stores a pixel intensity value. 0 is black, 256 is white.
  - The colour mode used is GL\_LUMINANCE. This uses a single number to represent a pixel's intensity. In this case we want 256 shades of grey, which is best stored in eight bits, so GL\_UNSIGNED\_BYTE is specified as the pixel data type.

To compile adapt the code below wo match your filenames:

```
nvcc -o ip_coursework_014 CUDA 'ip_coursework_014.cu' -lglut -lGL -lm
```

To run the program:

`./ip_coursework_014_CUDA`

Dr Kevan Buckley, University of Wolverhampton, 2018

```
#define width 100  
#define height 72
```

```
unsigned char data[width * height];
```















```

static void key_pressed(unsigned char key, int x, int y) {
    switch(key){
        case 27: // escape
            tidy_and_exit();
            break;
    default:
        printf("\nPress escape to exit\n");
        break;
    }
}

int time_difference(struct timespec *start, struct timespec *finish,
                    long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
    *difference = ds * 1000000000 + dn;
    return !(*difference > 0);
}

int main(int argc, char **argv) {
    signal(SIGINT, sigint_callback);

    printf("image dimensions %dx%d\n", width, height);
    unsigned char *device_data;
    unsigned char *device_image;

    struct timespec start, finish;
    long long int time_elapsed;

    clock_gettime(CLOCK_MONOTONIC, &start);

    cudaMalloc((void**)&device_data, sizeof(unsigned char) * (width * height));
    cudaMalloc((void**)&device_image, sizeof(unsigned char) * (width * height));
    cudaMemcpy(device_image, &image, sizeof(unsigned char) * (width * height),
    cudaMemcpyHostToDevice);
    cudaMemcpy(&device_data, &data, sizeof(unsigned char) * (width * height),
    cudaMemcpyHostToDevice);

    detect_edges <<<7200, 1>>>(device_image, device_data);
    cudaThreadSynchronize();

    cudaMemcpy(&data, device_data, sizeof(unsigned char) * (width * height),
    cudaMemcpyDeviceToHost);
    cudaMemcpy(&image, &device_image, sizeof(unsigned char) * (width * height),
    cudaMemcpyDeviceToHost);

    cudaFree(&device_image);
    cudaFree(&device_data);

    clock_gettime(CLOCK_MONOTONIC, &finish);
    time_difference(&start, &finish, &time_elapsed);
}

```

```

printf("Time elapsed was %lldns or %0.9lfs\n", time_elapsed,
       (time_elapsed/1.0e9));

glutInit(&argc, argv);
glutInitWindowSize(width * 2, height);
glutInitDisplayMode(GLUT_SINGLE | GLUT_LUMINANCE);

glutCreateWindow("6CS005 Image Processing Courework");
glutDisplayFunc(display);
glutKeyboardFunc(key_pressed);
glClearColor(0.0, 1.0, 0.0, 1.0);

glutMainLoop();

tidy_and_exit();

return 0;
}

```

\*\*\*\*\*

b. Insert a table that shows running times for the original, multi-thread and CUDA versions.

Calculating running times for the original program, multi-thread version and CUDA version.			
	Time for original program in second.	Time for multi-thread program in second.	Time for CUDA program in second.
1 <sup>st</sup>	0.000244189	0.000276838	0.075386513
2 <sup>nd</sup>	0.000158769	0.000386129	0.074686924
3 <sup>rd</sup>	0.000134126	0.000563675	0.076007492
4 <sup>th</sup>	0.000124196	0.000390902	0.074578661
5 <sup>th</sup>	0.000320527	0.000624942	0.072643177
6 <sup>th</sup>	0.000182322	0.00058715	0.080916637
7 <sup>th</sup>	0.000297749	0.000371939	0.078102321
8 <sup>th</sup>	0.000330665	0.000629257	0.078525085
9 <sup>th</sup>	0.000338829	0.000600857	0.078103622
10 <sup>th</sup>	0.000286728	0.000544998	0.080501337
Total time:	0.0024181	0.004976687	0.769451769
Mean Time:	0.00024181	0.0004976687	0.0769451769

Q. Write a short analysis of the results

Ans:

From above table the mean time to run an original program is 0.00024181 Sec and for multi-thread program mean time is 0.0004976687 Sec and for CUDA program mean time is 0.0769451769 Sec . From the mean time we know that the CUDA version took more than original and multi-thread version because each CUDA thread processes an individual pixel, therefore given image that is of  $100 * 72 = 7200$  pixels which allows to run each thread block to 7200 threads in parallel . So, it took more time than other two programs.

## 2.3 Linear Regression

a. CUDA version Linear Regression Program.

```
#include <stdio.h>
#include <math.h>
#include <time.h>
#include <cuda_runtime_api.h>
#include <errno.h>
#include<malloc.h>

/*********************************************
* This program takes an initial estimate of m and c and finds the associated
* rms error. It is then used as a base to generate and evaluate 8 new estimates,
* which are steps in different directions in m-c space. The best estimate is
* then used as the base for another iteration of "generate and evaluate". This
* continues until none of the new estimates are better than the base. This is
* a gradient search for a minimum in mc-space.
*
* To compile:
*   nvcc -o lr_coursework_cuda 'lr_coursework _cuda.cu' -lm
*
* To run:
*   ./lr_coursework_cu
*
* Dr Kevan Buckley, University of Wolverhampton, 2018
*****,
typedef struct point_t {
    double x;
    double y;
} point_t;

point_t data[] = {
{77.23,150.76},{79.80,130.99},{72.07,129.56},{68.54,135.57},
{83.81,149.30},{85.64,146.39},{76.45,131.33},{84.98,160.16},
{65.01,144.98},{78.23,138.68},{80.13,138.82},{14.69,60.34},
{15.27,56.88},{42.63,99.46},{49.53,108.22},{46.79,114.60},
{74.02,138.49},{68.93,143.70},{29.07,78.24},{22.66,57.23},
{13.55,60.50},{24.42,89.84},{69.63,141.88},{68.20,121.97},
{13.52,67.63},{98.18,171.90},{96.84,167.57},{15.31,79.26},
{81.15,155.58},{7.24,42.23},{92.34,171.28},{7.59,35.72},
{86.80,140.15},{94.64,164.89},{55.48,117.90},{94.96,162.89},
{27.86,70.22},{58.08,132.89},{66.77,128.47},{74.02,138.16},
{0.44,37.42},{24.84,61.83},{36.74,93.20},{6.16,36.15},
{8.67,46.12},{62.84,120.85},{91.14,160.36},{38.19,92.96},
{38.61,86.03},{4.54,41.42},{7.66,45.15},{90.28,151.89},
{66.28,136.36},{14.97,53.68},{99.09,181.15},{4.32,37.34},
{28.45,70.87},{51.71,106.37},{72.04,154.43},{92.30,157.78},
{43.08,107.99},{68.79,133.45},{21.91,66.64},{0.87,21.60},
{37.19,90.34},{34.04,84.70},{31.02,84.13},{44.61,88.35},
{14.38,51.01},{65.07,131.80},{25.28,83.50},{57.93,103.46},
{63.70,133.50},{61.95,135.18},{25.10,71.75},{7.30,35.50},
{27.96,56.29},{56.46,101.30},{64.09,138.41},{84.80,156.70},
{82.47,148.81},{65.74,115.48},{2.20,50.31},{79.73,146.57},
{99.84,195.89},{75.87,157.39},{99.03,169.23},{1.04,37.54},
{90.77,169.12},{44.44,112.84},{53.09,117.78},{29.20,74.15},
{8.14,48.53},{75.40,151.29},{0.36,51.74},{44.53,109.50},
```

{17.21, 69.95}, {82.10, 153.97}, {10.85, 75.38}, {11.03, 37.76},  
 {43.62, 95.03}, { 4.17, 37.63}, {42.83, 86.76}, {94.99, 162.04},  
 {38.27, 103.19}, { 8.92, 31.66}, { 5.91, 47.62}, {72.11, 147.98},  
 {21.67, 50.12}, {73.32, 150.38}, {89.72, 162.56}, {21.43, 63.83},  
 {38.87, 87.30}, {57.55, 108.29}, {95.32, 160.39}, {50.51, 102.08},  
 {40.26, 105.93}, { 1.42, 64.12}, {88.47, 165.02}, {60.40, 117.44},  
 {23.16, 61.15}, {31.47, 97.11}, {24.66, 65.60}, {15.71, 66.86},  
 {53.25, 100.04}, {25.62, 75.47}, {65.53, 127.89}, {20.46, 68.16},  
 {17.91, 67.45}, {58.56, 110.59}, {72.98, 137.58}, {41.63, 81.83},  
 {52.35, 131.31}, {42.70, 81.87}, {18.82, 63.87}, {82.37, 135.43},  
 {50.63, 118.03}, {26.69, 86.74}, {38.28, 96.89}, {79.50, 149.35},  
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{11.58, 45.54}, {47.52, 115.01}, {50.02, 113.78}, {95.50, 184.29},
{43.90, 87.31}, {50.31, 92.19}, {57.40, 110.42}, {41.27, 95.48},
{52.73, 122.70}, {97.37, 181.72}, {87.18, 156.97}, {0.27, 27.24},
{32.53, 78.79}, {94.39, 163.45}, {29.47, 74.81}, {20.24, 73.08},
{4.56, 59.03}, {38.65, 90.42}, {63.17, 145.59}, {12.77, 49.40},
{14.36, 72.37}, {71.92, 127.46}, {35.96, 72.29}, {54.82, 105.88},
{30.31, 90.56}, {70.58, 121.99}, {46.53, 104.57}, {83.62, 164.66},
{10.50, 43.60}, {27.90, 68.17}, {46.54, 100.24}, {48.49, 115.46},
{53.57, 109.34}, {19.56, 55.62}, {81.20, 152.35}, {55.46, 96.62},
{94.19, 158.45}, {56.27, 124.61}, {80.51, 146.14}, {67.37, 141.02},
{31.71, 89.49}, {93.04, 161.28}, {42.11, 91.72}, {33.56, 93.79},
{4.44, 60.08}, {8.21, 47.86}, {90.51, 177.18}, {27.26, 73.60},
{29.63, 85.02}, {52.43, 112.75}, {73.07, 130.27}, {1.79, 20.71},
{28.08, 81.49}, {51.24, 117.62}, {47.53, 109.75}, {79.66, 172.71},
{15.43, 51.60}, {39.10, 78.55}, {48.00, 114.36}, {2.19, 39.04},
{16.43, 49.62}, {47.88, 102.29}, {24.64, 68.34}, {57.88, 127.64},
{34.97, 95.54}, {4.03, 42.88}, {10.94, 60.98}, {36.51, 105.88},
{74.16, 142.76}, {25.29, 69.47}, {59.63, 112.76}, {2.42, 39.41},
{61.17, 115.63}, {0.02, 57.34}, {82.24, 158.82}, {84.95, 156.06},
{38.16, 65.51}, {29.66, 89.43}, {84.26, 144.66}, {37.30, 90.54},
{47.88, 108.10}, {99.07, 171.56}, {5.35, 46.07}, {91.88, 159.90},
{66.92, 118.74}, {51.63, 104.98}, {86.92, 149.65}, {91.78, 168.41}
};

int n_data = 1000;

double residual_error(double x, double y, double m, double c) {
    double e = (m * x) + c - y;
    return e * e;
}

```

```

__device__ double device_residual_error(double x, double y, double m, double c)
{
    double e = (m * x) + c - y;
    return e * e;
}
__global__ void device_rms_error(double *m, double *c, double *sum_error,
point_t *data_d) {
    int i = threadIdx.x + blockIdx.x * blockDim.x;
    sum_error[i] = device_residual_error(data_d[i].x, data_d[i].y, *m, *c);
}

double rms_error(double m, double c) {
    int i;
    double mean;
    double error_sum = 0;

    for(i=0; i<n_data; i++) {
        error_sum += residual_error(data[i].x, data[i].y, m, c);
    }

    mean = error_sum / n_data;

    return sqrt(mean);
}

int time_difference(struct timespec *start,
                     struct timespec *finish,
                     long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
    *difference = ds * 1000000000 + dn;
    return !(*difference > 0);
}

int main() {

    struct timespec start, finish;
    long long int time_elapsed;
    clock_gettime(CLOCK_MONOTONIC, &start);

    int i,l;
    cudaError_t error;
    double bm = 1.3;
    double bc = 10;
    double be;
    double dm[8];
    double dc[8];
    double e[8];
    double step = 0.01;
}

```

```

double best_error = 999999999;
int best_error_i;
int minimum_found = 0;

double om[] = {0,1,1, 1, 0,-1,-1,-1};
double oc[] = {1,1,0,-1,-1,-1, 0, 1};
be = rms_error(bm, bc);
double *data_dm;
double *data_dc;
double *data_sum_error;
point_t *data_d;

//Allocate memory for data_dm
error = cudaMalloc(&data_dm, (sizeof(double) * 8));
if(error){
    fprintf(stderr, "cudaMalloc on data_dm returned %d %s\n", error,
            cudaGetErrorString(error));
    exit(1);
}

//Allocate memory for data_dc
error = cudaMalloc(&data_dc, (sizeof(double) * 8));
if(error){
    fprintf(stderr, "cudaMalloc on data_dc returned %d %s\n", error,
            cudaGetErrorString(error));
    exit(1);
}

//Allocate memory for data_sum_error
error = cudaMalloc(&data_sum_error, (sizeof(double) * 1000));
if(error){
    fprintf(stderr, "cudaMalloc on data_sum_error returned %d %s\n", error,
            cudaGetErrorString(error));
    exit(1);
}

//Allocate memory for data_d
error = cudaMalloc(&data_d, sizeof(data));
if(error){
    fprintf(stderr, "cudaMalloc on data_d returned %d %s\n", error,
            cudaGetErrorString(error));
    exit(1);
}

while(!minimum_found) {
    for(i=0;i<8;i++) {
        dm[i] = bm + (om[i] * step);
        dc[i] = bc + (oc[i] * step);
    }

    //Copy memory for dm to data_dm
    error = cudaMemcpy(data_dm, dm, (sizeof(double) * 8),
                      cudaMemcpyHostToDevice);
    if(error){
        fprintf(stderr, "cudaMemcpy to data_dm returned %d %s\n", error,
                cudaGetErrorString(error));
    }
}

//Copy memory for dc to data_dc

```

```

error = cudaMemcpy(data_dc, dc, (sizeof(double) * 8),
cudaMemcpyHostToDevice);
if(error){
    fprintf(stderr, "cudaMemcpy to data_dc returned %d %s\n", error,
cudaGetString(error));
}

//Copy memory for data to data_d
error = cudaMemcpy(data_d, data, sizeof(data), cudaMemcpyHostToDevice);
if(error){
    fprintf(stderr, "cudaMemcpy to data_d returned %d %s\n", error,
cudaGetString(error));
}

for(i=0;i<8;i++) {

    double Host_sum_error[1000];
    double total_error_sum;
    double mean_sum_error;
    device_rms_error <<<10,100>>>(&data_dm[i], &data_dc[i],
data_sum_error, data_d);
    cudaThreadSynchronize();

    //Copy memory for data_sum_error
    error = cudaMemcpy(&Host_sum_error, data_sum_error,
(sizeof(double) * 1000),
cudaMemcpyDeviceToHost);
    if(error){
        fprintf(stderr, "cudaMemcpy to error_sum returned %d %s\n", error,
cudaGetString(error));
    }

    //Loop for the error_sum returned from the kernel
    //function
    for( l=0; l<n_data; l++) {
        //Add each error sum to the error sum total.
        total_error_sum += Host_sum_error[l];
    }

    //Calculate the mean for the error sum.
    mean_sum_error = total_error_sum / n_data;

    //Calculate the square root for the error sum mean.
    e[i] = sqrt(mean_sum_error);

    if(e[i] < best_error) {
        best_error = e[i];
        best_error_i = i;
    }

    total_error_sum = 0;
}

/*printf("best m,c is %lf,%lf with error %lf in direction %d\n",
dm[best_error_i], dc[best_error_i], best_error, best_error_i);*/

if(best_error < be) {

```

```

        be = best_error;
        bm = dm[best_error_i];
        bc = dc[best_error_i];
    } else {
        minimum_found = 1;
    }
}

//Free memory for data_dm
error = cudaFree(data_dm);
if(error){
    fprintf(stderr, "cudaFree on data_dm returned %d %s\n", error,
            cudaGetErrorString(error));
    exit(1);
}

//Free memory for data_dc
error = cudaFree(data_dc);
if(error){
    fprintf(stderr, "cudaFree on data_dc returned %d %s\n", error,
            cudaGetErrorString(error));
    exit(1);
}

//Free memory for data_d
error = cudaFree(data_d);
if(error){
    fprintf(stderr, "cudaFree on data_d returned %d %s\n", error,
            cudaGetErrorString(error));
    exit(1);
}

//Free memory for data_sum_error
error = cudaFree(data_sum_error);
if(error){
    fprintf(stderr, "cudaFree on data_sum_error returned %d %s\n",
            error, cudaGetErrorString(error));
    exit(1);
}

printf("minimum m,c is %lf,%lf with error %lf\n", bm, bc, be);

clock_gettime(CLOCK_MONOTONIC, &finish);
time_difference(&start, &finish, &time_elapsed);
printf("Time elapsed was %lldns or %0.9lfs\n", time_elapsed,
       (time_elapsed/1.0e9));

return 0;
}
*****

```

b. Insert a table that shows running times for the original, multi-thread and CUDA versions.

Calculating running times for the original program, multi-thread and CUDA version.			
	Time for original program in second.	Time for multi-thread program in second.	Time for CUDA program in second.
1 <sup>st</sup>	0.153255700	0.729684644	0.856547041
2 <sup>nd</sup>	0.154264022	0.730370932	0.835166268
3 <sup>rd</sup>	0.153620850	0.729603310	0.850222368
4 <sup>th</sup>	0.155420145	0.739406606	0.842416066
5 <sup>th</sup>	0.152466764	0.720501911	0.829854943
6 <sup>th</sup>	0.150451341	0.730797864	0.846832551
7 <sup>th</sup>	0.155607034	0.731083206	0.841985201
8 <sup>th</sup>	0.151813714	0.712123609	0.832571804
9 <sup>th</sup>	0.153453562	0.744400154	0.841029730
10 <sup>th</sup>	0.153750012	0.707047138	0.839885917
Total time:	1.534103144	7.275019374	8.416511889
Mean Time:	0.1534103144	0.7275019374	0.8416511889

Q. Write a short analysis of the results

Ans:

From above table the mean time to run an original program is 0.1534103144 Sec and for multi-thread program mean time is 0.7275019374 Sec and for CUDA program mean time is 0.8416511889 Sec . The mean running time of CUDA version is higher than other two programs because in CUDA version there are 1000 CUDA threads evaluating a single data point in parallel and the main CUDA kernel is called 8 times each for minimization iteration.

# 3 MPI

## 3.1 Password Cracking

a. MPI based Password Cracking.

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <crypt.h>
#include "time_diff.h"
#include <stdio.h>
#include <mpi.h>
#include <unistd.h>
/*********************************************************************
*****
Demonstrates how to crack an encrypted password using a simple
"brute force" algorithm. Works on passwords that consist only of 2
uppercase
letters and a 2 digit integer. Your personalised data set is included
in the
code.

Compile with:
mpicc -o CrackAZ99-With-Data-MPI CrackAZ99-With-Data-MPI.c time_diff.c -lcrypt

If you want to analyse the results then use the redirection operator
to send
output to a file that you can view using an editor or the less
utility:

mpiexec -n 3 ./CrackAZ99-With-Data-MPI

Dr Kevan Buckley, University of Wolverhampton, 2018
*****
*/
int n_passwords = 4;

char *encrypted_passwords[] = {
    "$6$KB$6SsUGf4Cq7/Oooym9WwQN3VKeo2lynKV9gXVyEG4HvYy1UFRx.XAye89TLp/
0TcW7cGpf9U1U0F.ck/S9CfZn1",
    "$6$KB$1vCJQRsKAizZvuTjEqLE./
zeAqZ7AdqzTdx5Tob.bQDRG1X0EVkNhuqMorBSvCp4fP0eoNm2wULs3DRABbrLQ/",
    "$6$KB$VKxGV/w3/
XgUswkstexjD72Q5jKKSTyxSFIQ1kwtApaQlnYvPfZA4038d1fc4QvWxDc93T4HzFF/ksMKgfzFM/",
    "$6$KB$xJHmCu7jpWBZlq2AAXZUB5ZF8NcJgZkydHbCyfPwy3nE.djI1SmUxHDLAZdnwz8ys5L8L9.61
NMdYXsyN32r11"
};

/**
Required by lack of standard function in C.
*/
```

```

void substr(char *dest, char *src, int start, int length){
    memcpy(dest, src + start, length);
    *(dest + length) = '\0';
}

<**
This function can crack the kind of password explained above. All
combinations
that are tried are displayed and when the password is found, #, is put
at the
start of the line. Note that one of the most time consuming operations
that
it performs is the output of intermediate results, so performance
experiments
for this kind of program should not include this. i.e. comment out the
printfs.
*/



void first_block_crack(char *salt_and_encrypted){
    int x, y, z;      // Loop counters
    char salt[7];    // String used in hashing the password. Need space
    char plain[7];   // The combination of letters currently being checked
    char *enc;        // Pointer to the encrypted password
    int count = 0;    // The number of combinations explored so far

    substr(salt, salt_and_encrypted, 0, 6);

    for(x='A'; x<='M'; x++){
        for(y='A'; y<='Z'; y++){
            for(z=0; z<=99; z++){
                printf("Instance 1");
                sprintf(plain, "%c%c%02d", x, y, z);
                enc = (char *) crypt(plain, salt);
                count++;
                if(strcmp(salt_and_encrypted, enc) == 0){
                    printf("#%-8d%s %s\n", count, plain, enc);
                } else {
                    printf(" %-8d%s %s\n", count, plain, enc);
                }
            }
        }
    }
    printf("%d solutions explored\n", count);
}

void second_block_crack(char *salt_and_encrypted){
    int x, y, z;      // Loop counters
    char salt[7];    // String used in hashing the password. Need space
    char plain[7];   // The combination of letters currently being checked
    char *enc;        // Pointer to the encrypted password
    int count = 0;    // The number of combinations explored so far

    substr(salt, salt_and_encrypted, 0, 6);

    for(x='N'; x<='Z'; x++){
        for(y='A'; y<='Z'; y++){
            for(z=0; z<=99; z++){
                printf("Instance 2");
                sprintf(plain, "%c%c%02d", x, y, z);
            }
        }
    }
}

```

```

        enc = (char *) crypt(plain, salt);
        count++;
        if(strcmp(salt_and_encrypted, enc) == 0){
            printf("#%-8d%$ %s\n", count, plain, enc);
        } else {
            printf(" %-8d%$ %s\n", count, plain, enc);
        }
    }
}
printf("%d solutions explored\n", count);
}

int main(int argc, char *argv[]){
    struct timespec start, finish;
    long long int time_elapsed;
    int account = 0;
    clock_gettime(CLOCK_MONOTONIC, &start);

    int size, rank;

    MPI_Init(NULL, NULL);
    MPI_Comm_size(MPI_COMM_WORLD, &size);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    if(size != 3) {
        if(rank == 0) {
            printf("This program needs to run on exactly 3 processes\n");
        }
    } else {
        if(rank == 0){
            int x;
            int y;
            int i;
            MPI_Send(&x, 1, MPI_INT, 1, 0, MPI_COMM_WORLD);
            MPI_Send(&y, 1, MPI_INT, 2, 0, MPI_COMM_WORLD);
        } else {
            if(rank == 1){
                int i;
                int number = rank + 10;
                MPI_Recv(&number, 1, MPI_INT, 0, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
                for ( i = 0; i<n_passwords;i<i++){
                    first_block_crack(encrypted_passwords[i]);
                }
            }
            else if(rank == 2){
                int i;
                int number = rank + 10;
                MPI_Recv(&number, 1, MPI_INT, 0, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
                for ( i = 0; i<n_passwords;i<i++){
                    second_block_crack(encrypted_passwords[i]);
                }
            }
        }
    }
    MPI_Finalize();
}

```

```
clock_gettime(CLOCK_MONOTONIC, &finish);
time_difference(&start, &finish, &time_elapsed);

printf("Elapsed Time: %0.9lf s or %0.9lf min\n", (time_elapsed/1.0e9),
((time_elapsed/1.0e9)/60));

return 0;
}

/*********************************************/
```

b. Insert a table that shows running times for the original, multi-thread version, CUDA version and MPI versions.

Calculating running times for the original program, multi-thread version, CUDA version and MPI versions.				
S.NO.	Time for original program.	Time for multi-thread program.	Time for CUDA program.	Time for MPI program.
1 <sup>st</sup>	852.086086160 Sec	424.101145135 Sec	0.109940907 Sec	448.548901729 Sec
2 <sup>nd</sup>	852.851117573 Sec	428.928177644 Sec	0.103769861 Sec	450.614477814 Sec
3 <sup>rd</sup>	866.621660790 Sec	428.028800344 Sec	0.103947175 Sec	457.101931998 Sec
4 <sup>th</sup>	841.839096854 Sec	426.398617337 Sec	0.106515338 Sec	452.628022154 Sec
5 <sup>th</sup>	870.891680057 Sec	432.247245291 Sec	0.111379871 Sec	459.816985690 Sec
6 <sup>th</sup>	825.242112556 Sec	430.344344965 Sec	0.107143562 Sec	450.138745586 Sec
7 <sup>th</sup>	864.673123279 Sec	430.50855403 Sec	0.111375666 Sec	453.292350263 Sec
8 <sup>th</sup>	877.859196113 Sec	431.871656769 Sec	0.110901209 Sec	458.325443892 Sec
9 <sup>th</sup>	871.069347481 Sec	433.916258052 Sec	0.109263462 Sec	455.466813751 Sec
10 <sup>th</sup>	854.746969314 Sec	475.311364531 Sec	0.115912735 Sec	457.408307580 Sec
Total time:	8577.88039018 Sec	4341.656164098 Sec	1.090149786 Sec	4543.341980457 Sec
Mean Time in sec:	857.788039018 Sec	434.1656164098 Sec	0.1090149786 Sec	454.3341980457 Sec
Mean Time in Min :	14.296467317 Min	7.23609360683 Min	0.00181691631 Min	7.572236634095 Min

Q. Write a short analysis of the results

Ans:

From above table the mean time to run an original program is 14.296467317 Min and for multi-thread program mean time is 7.23609360683 Min and for CUDA program mean time is 0.1090149786 Sec or 0.00181691631 Min and for MPI program mean time is 7.572236634095 Min. The running time of MPI version password cracking is more than that of original version only and near to multi-thread version. Because in MPI version a master share a work to the two compute instances i.e. instance 1 explore from AA to MZ and instance 2 explore from NA to ZZ.

## 3.2 Image Processing

a. MPI based Image Processing Program.

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <GL/glut.h>
#include <GL/gl.h>
#include <malloc.h>
#include <signal.h>
#include <mpi.h>
*****
Displays two grey scale images. On the left is an image that has come from an
image processing pipeline, just after colour thresholding. On the right is
the result of applying an edge detection convolution operator to the left
image. This program performs that convolution.
```

Things to note:

- A single unsigned char stores a pixel intensity value. 0 is black, 256 is white.
- The colour mode used is GL\_LUMINANCE. This uses a single number to represent a pixel's intensity. In this case we want 256 shades of grey, which is best stored in eight bits, so GL\_UNSIGNED\_BYTE is specified as the pixel data type.

To compile adapt the code below wo match your filenames:

```
mpicc -o ip_coursework_014_mpi 'ip_coursework_014_mpi.c' -lglut -lGL -lm
```

To run the program:

```
mpiexec -n 5 ./ip_coursework_014_mpi
```

Dr Kevan Buckley, University of Wolverhampton, 2018

```
*****
#define width 100
#define height 72

unsigned char image[], data[width * height];
int start, end;
int time_difference(struct timespec *start, struct timespec *finish,
                     long long int *difference);
void detect_edges(unsigned char *in, unsigned char *out);
static void key_pressed(unsigned char key, int x, int y);
void sigint_callback(int signal_number);
static void display();
void tidy_and_exit();

void detect_edges(unsigned char *in, unsigned char *out) {
    int i;
    int n_pixels = width * height;

    for(i=0;i<n_pixels;i++) {
        int x, y; // the pixel of interest
        int b, d, f, h; // the pixels adjacent to x,y used for the calculation
        int r; // the result of calculate

        y = i / width;
```

```

x = i - (width * y);

if (x == 0 || y == 0 || x == width - 1 || y == height - 1) {
    data[i] = 0;
} else {
    b = i + width;
    d = i - 1;
    f = i + 1;
    h = i - width;

    r = (in[i] * 4) + (in[b] * -1) + (in[d] * -1) + (in[f] * -1)
        + (in[h] * -1);

    if (r > 0) { // if the result is positive this is an edge pixel
        out[i] = 255;
    } else {
        out[i] = 0;
    }
}
}

void tidy_and_exit() {
    exit(0);
}

void sigint_callback(int signal_number){
    printf("\nInterrupt from keyboard\n");
    tidy_and_exit();
}

static void display() {
    glClear(GL_COLOR_BUFFER_BIT);
    glRasterPos4i(-1, -1, 0, 1);
    glDrawPixels(width, height, GL_LUMINANCE, GL_UNSIGNED_BYTE, image);
    glRasterPos4i(0, -1, 0, 1);
    glDrawPixels(width, height, GL_LUMINANCE, GL_UNSIGNED_BYTE, data);
    glFlush();
}

static void key_pressed(unsigned char key, int x, int y) {
    switch(key){
        case 27: // escape
            tidy_and_exit();
            break;
        default:
            printf("\nPress escape to exit\n");
            break;
    }
}

int time_difference(struct timespec *start, struct timespec *finish,
                     long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
}

```

```

}

*difference = ds * 1000000000 + dn;
return !(*difference > 0);
}

int main(int argc, char **argv) {
    signal(SIGINT, sigint_callback);

    printf("image dimensions %dx%d\n", width, height);

    int size, rank;
    MPI_Init(NULL, NULL);
    MPI_Comm_size(MPI_COMM_WORLD, &size);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);

    if (size !=5){
        printf("This program needs exactly 5 instances.\n");
        exit(-1);
    }

}

if(rank == 0){

    struct timespec start, finish;
    long long int time_elapsed;

    clock_gettime(CLOCK_MONOTONIC, &start);

    detect_edges(image, data);

    //data, receive
    MPI_Recv(&data[0], 1800,
    MPI_UNSIGNED_CHAR, 1, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
    MPI_Recv(&data[1800], 1800,
    MPI_UNSIGNED_CHAR, 2, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
    MPI_Recv(&data[3600], 1800,
    MPI_UNSIGNED_CHAR, 3, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
    MPI_Recv(&data[5400], 1800,
    MPI_UNSIGNED_CHAR, 4, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);

    clock_gettime(CLOCK_MONOTONIC, &finish);
    time_difference(&start, &finish, &time_elapsed);
    printf("Time elapsed was %lldns or %.9lfs\n", time_elapsed,
        (time_elapsed/1.0e9));

    glutInit(&argc, argv);
    glutInitWindowSize(width * 2, height);
    glutInitDisplayMode(GLUT_SINGLE | GLUT_LUMINANCE);

    glutCreateWindow("6CS005 Image Processing Courework");
    glutDisplayFunc(display);
    glutKeyboardFunc(key_pressed);
    glClearColor(0.0, 1.0, 0.0, 1.0);

    glutMainLoop();
}

```















```
0,0,0,0,0,0,0,0,255,0,0,0,0,0,0,  
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,  
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,  
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,  
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,  
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0  
};
```

```
/*****************************************************************************
```

b. Insert a table that shows running times for the original program, multi-thread, CUDA and MPI version.

Calculating running times for the original program, multi-thread, CUDA and MPI version.				
S.NO.	Time for original program in second.	Time for multi-thread program in second.	Time for CUDA program in second.	Time for MPI program in second.
1 <sup>st</sup>	0.000244189	0.000276838	0.075386513	0.000154116
2 <sup>nd</sup>	0.000158769	0.000386129	0.074686924	0.000158521
3 <sup>rd</sup>	0.000134126	0.000563675	0.076007492	0.000199504
4 <sup>th</sup>	0.000124196	0.000390902	0.074578661	0.000170938
5 <sup>th</sup>	0.000320527	0.000624942	0.072643177	0.000440511
6 <sup>th</sup>	0.000182322	0.00058715	0.080916637	0.000490878
7 <sup>th</sup>	0.000297749	0.000371939	0.078102321	0.001663067
8 <sup>th</sup>	0.000330665	0.000629257	0.078525085	0.000300530
9 <sup>th</sup>	0.000338829	0.000600857	0.078103622	0.000469621
10 <sup>th</sup>	0.000286728	0.000544998	0.080501337	0.000458685
Total time:	0.0024181	0.004976687	0.769451769	0.004506371
Mean Time:	0.00024181	0.0004976687	0.0769451769	0.0004506371

Q. Write a short analysis of the results

Ans:

From above table the mean time to run an original program is 0.00024181 Sec and for multi-thread program mean time is 0.0004976687 Sec and for CUDA program mean time is 0.0769451769 Sec and for MPI program mean time is 0.0004506371 Sec. The mean time of MPI version of image processing program is alike multi-threading but less than that of original program and more than that of CUDA version. Because the program uses 4 MPI instance to process each quarter of the image in a horizontal band and the master share the work and at last collate the results back into one image.

### 3.3 Linear Regression

#### a. MPI based Linear Regression

```
#include <stdio.h>
#include <math.h>
#include <time.h>
#include <mpi.h>
#include <stdlib.h>
/*********************************************************/
* This program takes an initial estimate of m and c and finds the associated
* rms error. It is then used as a base to generate and evaluate 8 new estimates,
* which are steps in different directions in m-c space. The best estimate is
* then used as the base for another iteration of "generate and evaluate". This is
* continues until none of the new estimates are better than the base. This is
* a gradient search for a minimum in mc-space.
*
* To compile:
*   mpicc -o lr_coursework_mpi 'lr_coursework _mpi.c' -lm
*
* To run:
*   mpiexec -n 9 ./lr_coursework_mpi
*
* Dr Kevan Buckley, University of Wolverhampton, 2018
/*********************************************************/
typedef struct point_t {
    double x;
    double y;
} point_t;

point_t data[] = {
{77.23, 150.76}, {79.80, 130.99}, {72.07, 129.56}, {68.54, 135.57},
{83.81, 149.30}, {85.64, 146.39}, {76.45, 131.33}, {84.98, 160.16},
{65.01, 144.98}, {78.23, 138.68}, {80.13, 138.82}, {14.69, 60.34},
{15.27, 56.88}, {42.63, 99.46}, {49.53, 108.22}, {46.79, 114.60},
{74.02, 138.49}, {68.93, 143.70}, {29.07, 78.24}, {22.66, 57.23},
{13.55, 60.50}, {24.42, 89.84}, {69.63, 141.88}, {68.20, 121.97},
{13.52, 67.63}, {98.18, 171.90}, {96.84, 167.57}, {15.31, 79.26},
{81.15, 155.58}, {7.24, 42.23}, {92.34, 171.28}, {7.59, 35.72},
{86.80, 140.15}, {94.64, 164.89}, {55.48, 117.90}, {94.96, 162.89},
{27.86, 70.22}, {58.08, 132.89}, {66.77, 128.47}, {74.02, 138.16},
{0.44, 37.42}, {24.84, 61.83}, {36.74, 93.20}, {6.16, 36.15},
{8.67, 46.12}, {62.84, 120.85}, {91.14, 160.36}, {38.19, 92.96},
{38.61, 86.03}, {4.54, 41.42}, {7.66, 45.15}, {90.28, 151.89},
{66.28, 136.36}, {14.97, 53.68}, {99.09, 181.15}, {4.32, 37.34},
{28.45, 70.87}, {51.71, 106.37}, {72.04, 154.43}, {92.30, 157.78},
{43.08, 107.99}, {68.79, 133.45}, {21.91, 66.64}, {0.87, 21.60},
{37.19, 90.34}, {34.04, 84.70}, {31.02, 84.13}, {44.61, 88.35},
{14.38, 51.01}, {65.07, 131.80}, {25.28, 83.50}, {57.93, 103.46},
{63.70, 133.50}, {61.95, 135.18}, {25.10, 71.75}, {7.30, 35.50},
{27.96, 56.29}, {56.46, 101.30}, {64.09, 138.41}, {84.80, 156.70},
{82.47, 148.81}, {65.74, 115.48}, {2.20, 50.31}, {79.73, 146.57},
{99.84, 195.89}, {75.87, 157.39}, {99.03, 169.23}, {1.04, 37.54},
{90.77, 169.12}, {44.44, 112.84}, {53.09, 117.78}, {29.20, 74.15},
{8.14, 48.53}, {75.40, 151.29}, {0.36, 51.74}, {44.53, 109.50},
{17.21, 69.95}, {82.10, 153.97}, {10.85, 75.38}, {11.03, 37.76},
{43.62, 95.03}, {4.17, 37.63}, {42.83, 86.76}, {94.99, 162.04},
```

{38.27, 103.19}, { 8.92, 31.66}, { 5.91, 47.62}, {72.11, 147.98},  
 {21.67, 50.12}, {73.32, 150.38}, {89.72, 162.56}, {21.43, 63.83},  
 {38.87, 87.30}, {57.55, 108.29}, {95.32, 160.39}, {50.51, 102.08},  
 {40.26, 105.93}, { 1.42, 64.12}, {88.47, 165.02}, {60.40, 117.44},  
 {23.16, 61.15}, {31.47, 97.11}, {24.66, 65.60}, {15.71, 66.86},  
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 {53.18, 106.68}, {42.09, 92.69}, {12.12, 47.44}, {55.74, 126.06},  
 {12.73, 71.40}, {47.39, 102.06}, {66.37, 128.93}, {11.89, 56.14},  
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 {55.04, 131.68}, {88.24, 149.22}, {55.56, 108.54}, {99.68, 179.53},  
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 {25.30, 78.38}, {96.33, 195.65}, {77.88, 138.48}, { 8.50, 39.79},  
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 {21.32, 73.28}, {95.18, 170.16}, { 2.38, 31.84}, {96.41, 173.78},  
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 { 2.73, 37.89}, {26.45, 77.66}, {37.03, 91.89}, {54.00, 124.50},  
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 {19.56, 68.73}, {54.48, 120.93}, {67.85, 119.02}, {24.27, 74.92},  
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 {34.40, 78.01}, {13.79, 65.82}, {6.27, 56.21}, {44.00, 103.71},  
 {83.26, 143.34}, {49.88, 101.41}, {73.05, 140.87}, {52.12, 104.77},  
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 {63.42, 98.06}, {6.04, 51.75}, {88.80, 134.59}, {10.57, 48.82},  
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 {95.21, 187.73}, {12.96, 57.68}, {47.92, 99.43}, {20.09, 47.75},  
 {74.33, 144.70}, {36.15, 79.94}, {83.59, 153.50}, {5.37, 46.07},  
 {98.97, 198.88}, {85.91, 179.15}, {95.38, 169.13}, {85.64, 160.16},  
 {56.06, 100.60}, {96.89, 176.63}, {83.93, 150.17}, {48.80, 111.06},  
 {22.27, 79.22}, {95.58, 173.58}, {56.49, 124.20}, {92.03, 146.39},  
 {66.49, 131.04}, {39.22, 90.96}, {17.98, 48.44}, {1.00, 33.27},  
 {80.50, 169.11}, {82.88, 173.50}, {57.92, 111.58}, {68.90, 130.96},  
 {38.65, 87.82}, {20.49, 73.50}, {58.10, 106.58}, {38.99, 88.07},  
 {41.65, 91.96}, {82.00, 140.65}, {33.81, 91.57}, {23.62, 78.38},  
 {75.76, 151.93}, {40.42, 116.08}, {30.84, 84.99}, {76.73, 148.69},  
 {7.81, 62.57}, {66.31, 134.40}, {70.76, 143.33}, {16.91, 60.19},  
 {8.16, 44.28}, {72.52, 138.18}, {28.13, 66.46}, {70.97, 126.90},  
 {54.46, 112.39}, {61.94, 110.06}, {45.47, 92.99}, {90.78, 156.57},  
 {66.08, 109.59}, {12.35, 56.66}, {17.23, 52.58}, {71.21, 158.27},  
 {61.22, 122.83}, {50.62, 117.43}, {26.52, 54.24}, {57.46, 126.25},  
 {28.74, 90.15}, {10.49, 48.72}, {62.11, 138.78}, {79.20, 140.57},  
 {73.06, 141.61}, {19.01, 52.29}, {15.35, 51.63}, {98.03, 174.79},

```

{19.43, 73.68}, {57.18, 95.12}, {28.71, 84.43}, {56.17, 114.52},
{12.66, 50.03}, {35.83, 78.66}, {73.95, 137.25}, {96.68, 169.26},
{13.12, 70.59}, {72.84, 142.80}, {80.36, 150.96}, {29.96, 67.92},
{41.51, 98.54}, {51.54, 102.60}, {81.96, 131.69}, {74.14, 138.07},
{10.89, 57.54}, {68.18, 127.68}, {2.46, 49.79}, {51.99, 119.32},
{11.65, 55.78}, {75.74, 132.46}, {80.32, 146.13}, {96.60, 165.24},
{66.52, 147.54}, {18.28, 66.38}, {66.88, 138.55}, {66.37, 141.96},
{94.67, 179.38}, {56.35, 108.03}, {74.57, 130.64}, {59.22, 113.97},
{52.15, 104.28}, {46.60, 107.63}, {60.24, 126.30}, {75.58, 129.28},
{47.49, 100.09}, {96.21, 162.75}, {20.45, 68.77}, {39.10, 94.83},
{29.27, 76.85}, {8.94, 36.23}, {97.54, 167.51}, {13.40, 64.23},
{26.77, 72.87}, {85.95, 157.69}, {11.91, 43.38}, {65.80, 107.86},
{41.47, 89.57}, {77.07, 131.29}, {2.25, 41.23}, {21.29, 83.85},
{97.15, 164.38}, {33.93, 89.39}, {90.07, 158.68}, {1.90, 32.41},
{59.48, 126.95}, {18.54, 62.78}, {36.23, 97.52}, {86.61, 160.14},
{28.96, 57.15}, {15.98, 67.67}, {58.71, 127.68}, {45.96, 105.75},
{90.77, 155.07}, {72.45, 143.70}, {40.83, 85.07}, {40.26, 94.81},
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{82.71, 158.27}, {97.74, 181.81}, {57.87, 122.41}, {99.50, 182.94},
{77.02, 151.94}, {39.36, 86.25}, {2.21, 56.76}, {55.28, 132.20},
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{81.03, 147.97}, {26.37, 71.29}, {97.06, 185.07}, {90.27, 164.86},
{84.43, 162.64}, {77.12, 138.46}, {78.68, 141.56}, {60.29, 129.14},
{11.58, 45.54}, {47.52, 115.01}, {50.02, 113.78}, {95.50, 184.29},
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{28.08, 81.49}, {51.24, 117.62}, {47.53, 109.75}, {79.66, 172.71},
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{16.43, 49.62}, {47.88, 102.29}, {24.64, 68.34}, {57.88, 127.64},
{34.97, 95.54}, {4.03, 42.88}, {10.94, 60.98}, {36.51, 105.88},
{74.16, 142.76}, {25.29, 69.47}, {59.63, 112.76}, {2.42, 39.41},
{61.17, 115.63}, {0.02, 57.34}, {82.24, 158.82}, {84.95, 156.06},
{38.16, 65.51}, {29.66, 89.43}, {84.26, 144.66}, {37.30, 90.54},
{47.88, 108.10}, {99.07, 171.56}, {5.35, 46.07}, {91.88, 159.90},
{66.92, 118.74}, {51.63, 104.98}, {86.92, 149.65}, {91.78, 168.41}
};

int n_data = 1000;

double residual_error(double x, double y, double m, double c);
double rms_error(double m, double c);
int time_difference(struct timespec *start,
                     struct timespec *finish,
                     long long int *difference);

double residual_error(double x, double y, double m, double c) {

```

```

    double e = (m * x) + c - y;
    return e * e;
}

double rms_error(double m, double c) {
    int i;
    double mean;
    double error_sum = 0;

    for(i=0; i<n_data; i++) {
        error_sum += residual_error(data[i].x, data[i].y, m, c);
    }

    mean = error_sum / n_data;

    return sqrt(mean);
}

int time_difference(struct timespec *start,
                     struct timespec *finish,
                     long long int *difference) {
    long long int ds = finish->tv_sec - start->tv_sec;
    long long int dn = finish->tv_nsec - start->tv_nsec;

    if(dn < 0 ) {
        ds--;
        dn += 1000000000;
    }
    *difference = ds * 1000000000 + dn;
    return !(*difference > 0);
}

int main() {
    struct timespec start, finish;
    long long int time_elapsed;

    clock_gettime(CLOCK_MONOTONIC, &start);
    int i;
    double bm = 1.3;
    double bc = 10;
    double be;
    double dm[8];
    double dc[8];
    double e[8];
    double step = 0.01;
    double best_error = 999999999;
    int best_error_i;
    int minimum = 0;

    double om[] = {0,1,1, 1, 0,-1,-1,-1};
    double oc[] = {1,1,0,-1,-1,-1, 0, 1};

    be = rms_error(bm, bc);
    double dataError = 0;
    double dataMC[2];
    int rank,size;
    MPI_Init(NULL,NULL);
}

```

```

MPI_Comm_size(MPI_COMM_WORLD, &size);
MPI_Comm_rank(MPI_COMM_WORLD, &rank);

if (size != 9){
printf("This program needs exactly 9 instances.\n");
exit(-1);

}

while(!minimum) {

    if (rank != 0)
    {
        i = rank - 1;
        dm[i] = bm + (om[i] * step);
        dc[i] = bc + (oc[i] * step);
        dataError = rms_error (dm[i], dc[i]);

        MPI_Send (&dataError, 1, MPI_DOUBLE, 0, 0, MPI_COMM_WORLD);
        MPI_Send (&dm[i], 1, MPI_DOUBLE, 0, 0, MPI_COMM_WORLD);
        MPI_Send (&dc[i], 1, MPI_DOUBLE, 0, 0, MPI_COMM_WORLD);

        MPI_Recv (&bm, 1, MPI_DOUBLE, 0, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
        MPI_Recv (&bc, 1, MPI_DOUBLE, 0, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
        MPI_Recv (&minimum, 1, MPI_INT, 0, 0, MPI_COMM_WORLD,
        MPI_STATUS_IGNORE);
    }
    else
    {
        for (i = 1; i < size; i++)
        {
            MPI_Recv (&dataError, 1, MPI_DOUBLE, i, 0, MPI_COMM_WORLD,
            MPI_STATUS_IGNORE);
            MPI_Recv (&dm[i-1], 1, MPI_DOUBLE, i, 0, MPI_COMM_WORLD,
            MPI_STATUS_IGNORE);
            MPI_Recv (&dc[i-1], 1, MPI_DOUBLE, i, 0, MPI_COMM_WORLD,
            MPI_STATUS_IGNORE);
            if (dataError < best_error)
            {
                best_error = dataError;
                best_error_i = i - 1;

            }
        }
        /*printf ("best m,c is %lf,%lf with error %lf in direction %d\n",
        dm[best_error_i], dc[best_error_i], best_error, best_error_i);*/
        if (best_error < be)
        {
            be = best_error;
            bm = dm[best_error_i];
            bc = dc[best_error_i];
        }
        else
        {
            minimum = 1;
        }
    }
}

```

```

    }

    for (i = 1; i < size; i++)
    {
        MPI_Send (&bm, 1, MPI_DOUBLE, i, 0, MPI_COMM_WORLD);
        MPI_Send (&bc, 1, MPI_DOUBLE, i, 0, MPI_COMM_WORLD);
        MPI_Send (&minimum, 1, MPI_INT, i, 0, MPI_COMM_WORLD);
    }
}

if(rank==0) {
    printf ("minimum m,c is %lf,%lf with error %lf\n", bm, bc, be);
    clock_gettime(CLOCK_MONOTONIC, &finish);
    time_difference(&start, &finish, &time_elapsed);
    printf("Time elapsed was %lldns or %0.9lfs\n", time_elapsed,
           (time_elapsed/1.0e9));
}

MPI_Finalize();

return 0;
}

```

\*\*\*\*\*

b. Insert a table that shows running times for the original program, multi-thread, CUDA and MPI version.

Calculating running times for the original program, multi-thread, CUDA and MPI version.				
S.NO.	Time for original program in second.	Time for multi-thread program in second.	Time for CUDA program in second.	Time for MPI program in second.
1 <sup>st</sup>	0.153255700	0.729684644	0.856547041	0.350617769
2 <sup>nd</sup>	0.154264022	0.730370932	0.835166268	0.350534225
3 <sup>rd</sup>	0.153620850	0.729603310	0.850222368	0.325625286
4 <sup>th</sup>	0.155420145	0.739406606	0.842416066	0.365351802
5 <sup>th</sup>	0.152466764	0.720501911	0.829854943	0.321015101
6 <sup>th</sup>	0.150451341	0.730797864	0.846832551	0.369546042
7 <sup>th</sup>	0.155607034	0.731083206	0.841985201	0.385449326
8 <sup>th</sup>	0.151813714	0.712123609	0.832571804	0.325763605
9 <sup>th</sup>	0.153453562	0.744400154	0.841029730	0.362917380
10 <sup>th</sup>	0.153750012	0.707047138	0.839885917	0.348054527
Total time:	1.534103144	7.275019374	8.416511889	3.504875063
Mean Time:	0.1534103144	0.7275019374	0.8416511889	0.3504875063

Q. Write a short analysis of the results

Ans:

From above table the mean time to run an original program is 0.1534103144 Sec and for multi-thread program mean time is 0.7275019374 Sec and for CUDA program mean time is 0.8416511889 Sec and for MPI program mean time is 0.3504875063 Sec. The mean time of MPI version of linear regression program is more than that of multi-threading and CUDA version but less than that of original program. Because linear regression MPI version program uses 8 MPI instances, each to compute the error associated with a specific regression line. The master instance run the main program and use a different instance to compute the error associated with each slope(m) and intercept(c) which being explored.

## 4 Verbose Repository Log

Paste your verbose format repository log here. With subversion this can be achieved by the following:

commit 7f9c3d7200646037852ae51b5141bafba48323e8

Merge: 4de9c63 feeb963

Author: ashishshrestha135 <46160809+ashishshrestha135@users.noreply.github.com>

Date: Mon Dec 31 18:12:38 2018 +0545

Merge pull request #3 from ashishshrestha135/ashishshrestha135-patch-2

This is my third upload in github

commit feeb9637e6fb2a5b88a179cd830cf19174c7525

Author: ashishshrestha135 <46160809+ashishshrestha135@users.noreply.github.com>

Date: Mon Dec 31 18:11:44 2018 +0545

This is my third upload in github

commit 4de9c635cf1080530b511b62c418cfcc11d520bc8

Merge: f38c0fb 104752f

Author: ashishshrestha135 <46160809+ashishshrestha135@users.noreply.github.com>

Date: Sun Dec 30 12:46:18 2018 +0545

Merge pull request #2 from ashishshrestha135/ashishshrestha135-patch-1

Add files via upload

commit 104752f3530c307c6ae25433a31e4275b1475e41

Author: ashishshrestha135 <46160809+ashishshrestha135@users.noreply.github.com>

Date: Sun Dec 30 12:45:39 2018 +0545

Add files via upload

commit f38c0fb8b2fdccb48d10ff3fdf61f3e1872ed9b7

Merge: 8f1b4cb 211c7dd

Author: ashishshrestha135 <46160809+ashishshrestha135@users.noreply.github.com>

Date: Wed Dec 26 17:59:43 2018 +0545

Merge pull request #1 from ashishshrestha135/ashishshrestha135-hpc

this is my first upload to github

commit 211c7dda8a9069f7e6518916814b3ff4d5e5170a

Author: ashishshrestha135 <46160809+ashishshrestha135@users.noreply.github.com>

Date: Wed Dec 26 17:54:39 2018 +0545

this is my first upload to github

commit 8f1b4cbdd224dd54622f742dc6ff4018edd29240

Author: ashishshrestha135 <46160809+ashishshrestha135@users.noreply.github.com>

Date: Wed Dec 26 17:48:11 2018 +0545

Initial commit

## Appendex:

Screenshot of running time for password cracking original program.

1.

```

ashishshrestha@ashishshrestha:~/Documents/Assignment$ ./crack.py
[...]
Time elapsed was 852086086160ns or 852.086086160s
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 

```

2.

```

ashishshrestha@ashishshrestha:~/Documents/Assignment$ ./crack.py
[...]
Time elapsed was 852851117573ns or 852.851117573s
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 

```

3.

```
Terminal बुध 1:52 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment
File Edit View Search Terminal Help
67575 ZZ74 $6$KB$bYwf3VmYffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uYx9Cq8raZZgxYq/mo/
67576 ZZ75 $6$KB$bX2451iQQTftq049EHsbwLT79vKkyVvn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVNciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
67578 ZZ77 $6$KB$bR01Ef5K1Voc6KXNx55ikf70TwVMiPZESPztrNGHBNaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwPbir5wpqlJl.
67579 ZZ78 $6$KB$bEtgT36YAt8xlpqMgdceBUAngLdyg/hMifqg1XT2CH722xlM2fxJ1ccnXYn.gnGnsYvVPqs0tKqNgBkjwger0
67580 ZZ79 $6$KB$bjsU0fb6Vgy.uFyeY.rSXEB0eAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZTlFAMZlHbJ7Ec6Ja9RW0
67581 ZZ80 $6$KB$bKNA46P2pAMhjb233D8Q1kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUpt7iTB112.
67582 ZZ81 $6$KB$b093pWA16kSQzyleEt0kjk0x69uFQEbz9P.yD4s0YV3oss54B2JFLiWuJQkjm9g451p.CXFQ0LDfCTDn0N0d71
67583 ZZ82 $6$KB$b16CMCMoURkSt0ALmMYB3HnFOHqYnIUsEzNgYbIB4Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR//.
67584 ZZ83 $6$KB$b$vyseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm/1/nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
67585 ZZ84 $6$KB$b55xu.uAA902HKKvft4DuCyS19eKKTExCa/ZlkDcA8KmDQ/LUU4KfsK8A8pajt4wDVKH2M3ft15X.00ysHP190
67586 ZZ85 $6$KB$b1PqgwF2.75K/QfcSDbEsWk0ieRK6D6KAVQyEoW56.Duj96PdssQG20Qx474/VPYF4W7aoYGe80xIWKMkco.0
67587 ZZ86 $6$KB$b1D/FRkcrM23MBiISi4rjm.DH3n1P09nhYz07459ZXM0RDGj40w0pURZE6n0NWR13gwRW/NHqaTJLIM.aq070
67588 ZZ87 $6$KB$b98RtAp7wZrIHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnZBPO/2uFpPhT9AoSqtBuP7lqUjs3V1
67589 ZZ88 $6$KB$b$u9oc6jJpetheted5g0Sbx0M0UUp09rhny.5GugCcsWTSHy/3J2B3i180l0/hMMYyOTFXDd9dsrrTuqBRO/nPu11
67590 ZZ89 $6$KB$bC0zn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0dS8n3zfHewKqInqg9EG0uXyXYQjHjs/9idY.
67591 ZZ90 $6$KB$b.e.aMgv0H0do1dybMLGEK0DxyX39mXQz06GhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7EhXN3ps0cJNLG1
67592 ZZ91 $6$KB$b2eu/y9a0V3DSk3r8LAhqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
67593 ZZ92 $6$KB$bEnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
67594 ZZ93 $6$KB$b02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnvzbEPXMKLtdffkpo0JKB6LKw74M9sf6D3jv0y.cbU5BCR76/
67595 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cPIbv6KGoPMtpf7pbea9JFdfj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
67596 ZZ95 $6$KB$b$qmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RpBPyf4IhKFR1fL2xqNMO1kalRzzhev4jxdspPEuoRMFgoTbblrJ0
67597 ZZ96 $6$KB$bUrzgUnWyaGjoKrg7zk540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
67598 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmLEJkXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
67599 ZZ98 $6$KB$b$eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./.
67600 ZZ99 $6$KB$b.n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYlkkvNQEyg1PHCzjmcN8dH7431TL26VrxJaACBBHnoZx6ugcYkaSrf1
67600 solutions explored
Time elapsed was 866621660790ns or 866.621660790s
ashishshrestha@ashishshrestha: ~/Documents/Assignment$
```

4.

```
Terminal बुध 2:09 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment
File Edit View Search Terminal Help
67575 ZZ74 $6$KB$bYwf3VmYffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uYx9Cq8raZZgxYq/mo/
67576 ZZ75 $6$KB$bX2451iQQTftq049EHsbwLT79vKkyVvn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVNciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
67578 ZZ77 $6$KB$bR01Ef5K1Voc6KXNx55ikf70TwVMiPZESPztrNGHBNaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwPbir5wpqlJl.
67579 ZZ78 $6$KB$bEtgT36YAt8xlpqMgdceBUAngLdyg/hMifqg1XT2CH722xlM2fxJ1ccnXYn.gnGnsYvVPqs0tKqNgBkjwger0
67580 ZZ79 $6$KB$bjsU0fb6Vgy.uFyeY.rSXEB0eAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZTlFAMZlHbJ7Ec6Ja9RW0
67581 ZZ80 $6$KB$bKNA46P2pAMhjb233D8Q1kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUpt7iTB112.
67582 ZZ81 $6$KB$b093pWA16kSQzyleEt0kjk0x69uFQEbz9P.yD4s0YV3oss54B2JFLiWuJQkjm9g451p.CXFQ0LDfCTDn0N0d71
67583 ZZ82 $6$KB$b16CMCMoURkSt0ALmMYB3HnFOHqYnIUsEzNgYbIB4Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR//.
67584 ZZ83 $6$KB$b$vyseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm/1/nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
67585 ZZ84 $6$KB$b55xu.uAA902HKKvft4DuCyS19eKKTExCa/ZlkDcA8KmDQ/LUU4KfsK8A8pajt4wDVKH2M3ft15X.00ysHP190
67586 ZZ85 $6$KB$b1PqgwF2.75K/QfcSDbEsWk0ieRK6D6KAVQyEoW56.Duj96PdssQG20Qx474/VPYF4W7aoYGe80xIWKMkco.0
67587 ZZ86 $6$KB$b1D/FRkcrM23MBiISi4rjm.DH3n1P09nhYz07459ZXM0RDGj40w0pURZE6n0NWR13gwRW/NHqaTJLIM.aq070
67588 ZZ87 $6$KB$b98RtAp7wZrIHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnZBPO/2uFpPhT9AoSqtBuP7lqUjs3V1
67589 ZZ88 $6$KB$b$u9oc6jJpetheted5g0Sbx0M0UUp09rhny.5GugCcsWTSHy/3J2B3i180l0/hMMYyOTFXDd9dsrrTuqBRO/nPu11
67590 ZZ89 $6$KB$bC0zn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0dS8n3zfHewKqInqg9EG0uXyXYQjHjs/9idY.
67591 ZZ90 $6$KB$b.e.aMgv0H0do1dybMLGEK0DxyX39mXQz06GhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7EhXN3ps0cJNLG1
67592 ZZ91 $6$KB$b2eu/y9a0V3DSk3r8LAhqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
67593 ZZ92 $6$KB$bEnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
67594 ZZ93 $6$KB$b02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnvzbEPXMKLtdffkpo0JKB6LKw74M9sf6D3jv0y.cbU5BCR76/
67595 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cPIbv6KGoPMtpf7pbea9JFdfj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
67596 ZZ95 $6$KB$b$qmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RpBPyf4IhKFR1fL2xqNMO1kalRzzhev4jxdspPEuoRMFgoTbblrJ0
67597 ZZ96 $6$KB$bUrzgUnWyaGjoKrg7zk540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
67598 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmLEJkXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
67599 ZZ98 $6$KB$b$eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./.
67600 ZZ99 $6$KB$b.n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYlkkvNQEyg1PHCzjmcN8dH7431TL26VrxJaACBBHnoZx6ugcYkaSrf1
67600 solutions explored
Time elapsed was 841839096854ns or 841.839096854s
ashishshrestha@ashishshrestha: ~/Documents/Assignment$
```

5.

```
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

```
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```

```
67575 ZZ74 $6$KB$bYwf3VmYffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uYx9Cq8raZZgxYq/mo/
```

```
67576 ZZ75 $6$KB$bX2451iQQTftq049EHsbwLT79vKkyVvn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
```

```
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVnciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
```

```
67578 ZZ77 $6$KB$b01Ef5K1Voc6KXNx55ikf70TwVMiPZEPztrNGHBNaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwPbir5wpqlJl.
```

```
67579 ZZ78 $6$KB$bEtgT36YAt8xlpqMgdceBUAngLdyg/hMifqg1XT2CH722xlM2fxJ1ccnXN.ygnKsYvVPqs0tKqNgBkjwger0
```

```
67580 ZZ79 $6$KB$bjsU0fb6Vgy.uFyeY.rSXEB0eAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZtlhbJ7Ecx6Ja9Rw0
```

```
67581 ZZ80 $6$KB$bKNA46P2pAMhjb233D8Q1kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUpt7iwTB112.
```

```
67582 ZZ81 $6$KB$b093pWA16kSzqyleEt0k0x69uFQEB297P.yD4s0YV3oss54B2JFLiWuJQkjm9g451p.CXFQ0LDFcTDn0N0d71
```

```
67583 ZZ82 $6$KB$b16CMCMoURkSt0ALmMYBG3HnFOHqYnIUsEzNg6ybIB4Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR//
```

```
67584 ZZ83 $6$KB$bVvyseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm1/1nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
```

```
67585 ZZ84 $6$KB$b55xu.uAA902HKKvft4DuCyS19eKKTExCa/ZlkDca8KmDQ/LUU4KfsK8A8pajt4wDVKH2M3ft15X.00ysHPi90
```

```
67586 ZZ85 $6$KB$b1Pqgw4F2.75K/Qfc5DsEwsK0ieRK6D6KAVQyEoW56.Duj96PdssQG2QxX474/VPYF4W7aoYGeM8QxIWKMkco.0
```

```
67587 ZZ86 $6$KB$b1D/FRkcrM23MBiISi4rjm.DHY3n1P09nyhZ07459ZXM0RDGj40w0pURZE60nVWR13gwRW/NHqaTJLIM.aq070
```

```
67588 ZZ87 $6$KB$b98RtAp7wZriHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnZBPO/2uFpPhT9AoSqtBuP7lqUjs3V1
```

```
67589 ZZ88 $6$KB$b90c6jJpetheted5g0Sbx0M0UUp09rh.y5GuqCc5WTSHy/3J2B3i80l0/hMMYyOTFXDd9dssrTuqBRO/nPu11
```

```
67590 ZZ89 $6$KB$bC0zn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0dS8n3zfHewKqInq1g9EG0uXyXYQjHjs/9idY.
```

```
67591 ZZ90 $6$KB$b.e.aMgv0H0do1dybMLGEK0DxyX39mXQz06GhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7EhXN3ps0cJNLG1
```

```
67592 ZZ91 $6$KB$b2eu/y9a0V3DSk3r8LahqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
```

```
67593 ZZ92 $6$KB$bEnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
```

```
67594 ZZ93 $6$KB$b02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnxzEBPXMKLtfdfkpo0JKB6LKw74M9sf6D3jv0y.cbU5BCR76/
```

```
67595 ZZ94 $6$KB$bZafET5X77msPbHed1hs7crtU/2cPIbv6KGoPMtpf7pbea9JFdj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
```

```
67596 ZZ95 $6$KB$bqmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RbPyf4IhKFR1fL2xqNM0X1kalRzzhe4jxdspPEuoRMFgoTbblzrj0
```

```
67597 ZZ96 $6$KB$bUrzgUnWyaGjoKrg7zk540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
```

```
67598 ZZ97 $6$KB$bMilhksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmLEJkXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
```

```
67599 ZZ98 $6$KB$bvee8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./
```

```
67600 ZZ99 $6$KB$b.n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYIKkvNQEyg1PHCzjmcN8dH7431TL26VrxJaACBBHnoZx6ugcYkaSrf1
```

```
67600 solutions explored
```

```
Time elapsed was 870891680057ns or 870.891680057ns
```

```
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

6.

```
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

```
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```

```
67575 ZZ74 $6$KB$bYwf3VmYffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uYx9Cq8raZZgxYq/mo/
```

```
67576 ZZ75 $6$KB$bX2451iQQTftq049EHsbwLT79vKkyVvn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
```

```
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVnciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
```

```
67578 ZZ77 $6$KB$b01Ef5K1Voc6KXNx55ikf70TwVMiPZEPztrNGHBNaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwPbir5wpqlJl.
```

```
67579 ZZ78 $6$KB$bEtgT36YAt8xlpqMgdceBUAngLdyg/hMifqg1XT2CH722xlM2fxJ1ccnXN.ygnKsYvVPqs0tKqNgBkjwger0
```

```
67580 ZZ79 $6$KB$bjsU0fb6Vgy.uFyeY.rSXEB0eAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZtlhbJ7Ecx6Ja9Rw0
```

```
67581 ZZ80 $6$KB$bKNA46P2pAMhjb233D8Q1kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUpt7iwTB112.
```

```
67582 ZZ81 $6$KB$b093pWA16kSzqyleEt0k0x69uFQEB297P.yD4s0YV3oss54B2JFLiWuJQkjm9g451p.CXFQ0LDFcTDn0N0d71
```

```
67583 ZZ82 $6$KB$b16CMCMoURkSt0ALmMYBG3HnFOHqYnIUsEzNg6ybIB4Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR//
```

```
67584 ZZ83 $6$KB$bVvyseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm1/1nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
```

```
67585 ZZ84 $6$KB$b55xu.uAA902HKKvft4DuCyS19eKKTExCa/ZlkDca8KmDQ/LUU4KfsK8A8pajt4wDVKH2M3ft15X.00ysHPi90
```

```
67586 ZZ85 $6$KB$b1Pqgw4F2.75K/Qfc5DsEwsK0ieRK6D6KAVQyEoW56.Duj96PdssQG2QxX474/VPYF4W7aoYGeM8QxIWKMkco.0
```

```
67587 ZZ86 $6$KB$b1D/FRkcrM23MBiISi4rjm.DHY3n1P09nyhZ07459ZXM0RDGj40w0pURZE60nVWR13gwRW/NHqaTJLIM.aq070
```

```
67588 ZZ87 $6$KB$b98RtAp7wZriHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnZBPO/2uFpPhT9AoSqtBuP7lqUjs3V1
```

```
67589 ZZ88 $6$KB$b90c6jJpetheted5g0Sbx0M0UUp09rh.y5GuqCc5WTSHy/3J2B3i80l0/hMMYyOTFXDd9dssrTuqBRO/nPu11
```

```
67590 ZZ89 $6$KB$bC0zn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0dS8n3zfHewKqInq1g9EG0uXyXYQjHjs/9idY.
```

```
67591 ZZ90 $6$KB$b.e.aMgv0H0do1dybMLGEK0DxyX39mXQz06GhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7EhXN3ps0cJNLG1
```

```
67592 ZZ91 $6$KB$b2eu/y9a0V3DSk3r8LahqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
```

```
67593 ZZ92 $6$KB$bEnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
```

```
67594 ZZ93 $6$KB$b02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnxzEBPXMKLtfdfkpo0JKB6LKw74M9sf6D3jv0y.cbU5BCR76/
```

```
67595 ZZ94 $6$KB$bZafET5X77msPbHed1hs7crtU/2cPIbv6KGoPMtpf7pbea9JFdj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
```

```
67596 ZZ95 $6$KB$bqmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RbPyf4IhKFR1fL2xqNM0X1kalRzzhe4jxdspPEuoRMFgoTbblzrj0
```

```
67597 ZZ96 $6$KB$bUrzgUnWyaGjoKrg7zk540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
```

```
67598 ZZ97 $6$KB$bMilhksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmLEJkXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
```

```
67599 ZZ98 $6$KB$bvee8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./
```

```
67600 ZZ99 $6$KB$b.n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYIKkvNQEyg1PHCzjmcN8dH7431TL26VrxJaACBBHnoZx6ugcYkaSrf1
```

```
67600 solutions explored
```

```
Time elapsed was 825242112556ns or 825.242112556ns
```

```
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

7.

```

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67575 ZZ74 $6$KB$Ywf3VmyffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uXy9Cq8raZZgxYq/mo/
67576 ZZ75 $6$KB$X2451iQQTftq049EHsbwLT79vKkyVvn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVnciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
67578 ZZ77 $6$KB$rQ1EfP5K1Voc6KXNx55ikf70TwVmIPZEPztrNGHbnaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwPbir5wpqlJl.
67579 ZZ78 $6$KB$etgT36YAt8xlpqMgdceBUAngLdy/g/Hifqg1XT2CH722xlM2fxJ1ccnXyngNksYvVPqsQtKqNgBkjwger0
67580 ZZ79 $6$KB$jsU0fb6Vgy.uFyeY.rSXEBOeAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZtlhbJ7Ecx6Ja9Rw0
67581 ZZ80 $6$KB$KNA46P2pAMhjb233D8Q1kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUPt7iwTB112.
67582 ZZ81 $6$KB$o93pWA16kSzqyleEt0kjk0x69uFQEB297P.yD4s0YV3oss54B2JFLiWuJQkjmg9451p.CXFQ0LDFcTDn0N0d71
67583 ZZ82 $6$KB$16CMCMoURkSt0AlmMYB3HnFOHqYnIUsEzNgYbIB84Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR//.
67584 ZZ83 $6$KB$vyvseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm1/1nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
67585 ZZ84 $6$KB$55xu.uAA902HKKvf4DuCyS19eKKTExCa/ZlkDcA8KmDQ/LUU4KfsK8A8pjt4wDVKH2M3ft15X.00ysHPi90
67586 ZZ85 $6$KB$1Pqgw4F2.75K/QfcSdbEsWk0ieRK6D6KAVQyEoW56.Duj96PdssQG2QxX474/VPYF4W7aoYGe80xIWKMkco.0
67587 ZZ86 $6$KB$a1D/FRkcrM23MBiISi4rjm.DHY3n1P09nhzY07459ZXM0RDGj40w0pURZE6n0NWRi3gwRW/NHqaTJLIM.aq070
67588 ZZ87 $6$KB$98RtAp7wZriHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnzbpo/2uFpPhT9AoSqtBu7lqUjs3V1
67589 ZZ88 $6$KB$u9oc6jJpetheted5g0Sbx0M0UUp09rhny.5GuqCc5WTSHy/32B3i80l0/hMMYOTFXDd9dsrrTuqBRO/nPu11
67590 ZZ89 $6$KB$Cozn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0d58n3zfHewkqInqg9EG0uXyXYQjHjs/9idY.
67591 ZZ90 $6$KB$e.AMgv0H0do1dybMLGEK0DQxyX39mXQz06FhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7ehXN3ps0cJNLG1
67592 ZZ91 $6$KB$e2u/y9a0V3DSk3r8LahqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
67593 ZZ92 $6$KB$EnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
67594 ZZ93 $6$KB$02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnvzEBPXMKLtdffkpo00JKB6LKw74M9sf6D3jv0y.cbU5BCR76/
67595 ZZ94 $6$KB$ZafET5X77msPbHed1hs7crtU/2cPIbvR6KGoPMtpf7pbea9JFdj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
67596 ZZ95 $6$KB$qmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RpBPyf4IhKFR1fL2xqNM0X1kalRzzhe4jxdspPEuoRMFgoTbblzrj0
67597 ZZ96 $6$KB$uRzgUnWyaGjoKrg7zk540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
67598 ZZ97 $6$KB$MilhksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmlEJKXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
67599 ZZ98 $6$KB$eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129Qnb./
67600 ZZ99 $6$KB$n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYlkkvNQEygLPHCZjmcN8dH7431TL26VrxJaACBBHnoZx6ugcYkaSrf1
67600 solutions explored
Time elapsed was 864673123279ns or 864.673123279s
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 

```

8.

```

File Edit View Search Terminal Help
67575 ZZ74 $6$KB$Ywf3VmyffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uXy9Cq8raZZgxYq/mo/
67576 ZZ75 $6$KB$X2451iQQTftq049EHsbwLT79vKkyVvn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVnciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
67578 ZZ77 $6$KB$rQ1EfP5K1Voc6KXNx55ikf70TwVmIPZEPztrNGHbnaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwPbir5wpqlJl.
67579 ZZ78 $6$KB$etgT36YAt8xlpqMgdceBUAngLdy/g/Hifqg1XT2CH722xlM2fxJ1ccnXyngNksYvVPqsQtKqNgBkjwger0
67580 ZZ79 $6$KB$jsU0fb6Vgy.uFyeY.rSXEBOeAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZtlhbJ7Ecx6Ja9Rw0
67581 ZZ80 $6$KB$KNA46P2pAMhjb233D8Q1kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUPt7iwTB112.
67582 ZZ81 $6$KB$o93pWA16kSzqyleEt0kjk0x69uFQEB297P.yD4s0YV3oss54B2JFLiWuJQkjmg9451p.CXFQ0LDFcTDn0N0d71
67583 ZZ82 $6$KB$16CMCMoURkSt0AlmMYB3HnFOHqYnIUsEzNgYbIB84Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR//.
67584 ZZ83 $6$KB$vyvseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm1/1nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
67585 ZZ84 $6$KB$55xu.uAA902HKKvf4DuCyS19eKKTExCa/ZlkDcA8KmDQ/LUU4KfsK8A8pjt4wDVKH2M3ft15X.00ysHPi90
67586 ZZ85 $6$KB$1Pqgw4F2.75K/QfcSdbEsWk0ieRK6D6KAVQyEoW56.Duj96PdssQG2QxX474/VPYF4W7aoYGe80xIWKMkco.0
67587 ZZ86 $6$KB$a1D/FRkcrM23MBiISi4rjm.DHY3n1P09nhzY07459ZXM0RDGj40w0pURZE6n0NWRi3gwRW/NHqaTJLIM.aq070
67588 ZZ87 $6$KB$98RtAp7wZriHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnzbpo/2uFpPhT9AoSqtBu7lqUjs3V1
67589 ZZ88 $6$KB$u9oc6jJpetheted5g0Sbx0M0UUp09rhny.5GuqCc5WTSHy/32B3i80l0/hMMYOTFXDd9dsrrTuqBRO/nPu11
67590 ZZ89 $6$KB$Cozn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0d58n3zfHewkqInqg9EG0uXyXYQjHjs/9idY.
67591 ZZ90 $6$KB$e.aMgv0H0do1dybMLGEK0DQxyX39mXQz06FhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7ehXN3ps0cJNLG1
67592 ZZ91 $6$KB$e2u/y9a0V3DSk3r8LahqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
67593 ZZ92 $6$KB$EnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
67594 ZZ93 $6$KB$02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnvzEBPXMKLtdffkpo00JKB6LKw74M9sf6D3jv0y.cbU5BCR76/
67595 ZZ94 $6$KB$ZafET5X77msPbHed1hs7crtU/2cPIbvR6KGoPMtpf7pbea9JFdj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
67596 ZZ95 $6$KB$qmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RpBPyf4IhKFR1fL2xqNM0X1kalRzzhe4jxdspPEuoRMFgoTbblzrj0
67597 ZZ96 $6$KB$uRzgUnWyaGjoKrg7zk540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
67598 ZZ97 $6$KB$MilhksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmlEJKXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
67599 ZZ98 $6$KB$eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129Qnb./
67600 ZZ99 $6$KB$n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYlkkvNQEygLPHCZjmcN8dH7431TL26VrxJaACBBHnoZx6ugcYkaSrf1
67600 solutions explored
Time elapsed was 871069347481ns or 871.069347481s
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 

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9.

```

Terminal                                बुध 5:08 अपराह्न
ashishshrestha@ashishshrestha: ~/Documents/Assignment
File Edit View Search Terminal Help
67575 ZZ74 $6$KB$bYwf3VmyffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uYx9Cq8raZZgxYq/mo/
67576 ZZ75 $6$KB$bX2451iLQTFtq049EHsbwLT79vKkyVVn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVNciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
67578 ZZ77 $6$KB$bR01Ef5K1Voc6KXNx55ikf70TwVMiPZEPztrNGHBNaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwWpbir5wpqlJl.
67579 ZZ78 $6$KB$bEtgT36YAt8xlpqMgdceBUAngLdYg/hMifqg1XT2CH722xlM2fxJ1ccnXYn.gnGnsYvVPqs0tKqNgBkjwger0
67580 ZZ79 $6$KB$bjsU0fb6Vgy.uFYeY.rSXEB0eAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZtlhbJ7Ecx6Ja9Rw0
67581 ZZ80 $6$KB$bKNA46P2pAMhjb233D801kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUpt7iwTB112.
67582 ZZ81 $6$KB$b093pWA16kSQzyleETk0jK0x69uFQEbz9P.yD4s0YV3oss54B2JFLiWuJQkjm9g451p.CXFQ0LDFcTDn0N0d71
67583 ZZ82 $6$KB$b16CMCMoURkSt0ALmMYBG3HnFOHqYnIUsEzNgYbIB84Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR// 
67584 ZZ83 $6$KB$b$vyseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm1/1nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
67585 ZZ84 $6$KB$b55xu.uAA902HKKvft4DuCyS19eKKTExCa/ZlkDcA8KmDQ/LUU4KfsK8A8pajt4wDVKH2M3ft15X.00ysHPi90
67586 ZZ85 $6$KB$b1Pqgw4F2.75K/QfcSDbEsWk0ieRK6D6KAVQyEoW56.Duj96PdssQG2QxX474/VPYF4W7aoYGe80xIWKMkco.0
67587 ZZ86 $6$KB$b1D/FRKcrM23MBiISi4rjm.DHY3nP109nyZ07459ZXM0RDGj40w0pURZE6n0NWRi3gwRW/NHqaTJLIM.aq070
67588 ZZ87 $6$KB$b98RtAp7wZriHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnZBPO/2uFpPhT9AoSqtBu7lqUjs3V1
67589 ZZ88 $6$KB$b$u9oc6jJpetheted5g0Sbx0M0UUp09rh.y5GuqCc5WTSHy/3J2B3i80lQ/hMMYyOTFXDd9dssrTuqBRO/nPu11
67590 ZZ89 $6$KB$bC0zn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0dS8n3zfHewkqInqg9EG0uXyXYQjHjs/9idY.
67591 ZZ90 $6$KB$b.e.aMgv0H0do1dybMLGEK0DQxyX39mXQz0vGfhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7EhXN3ps0cJNLG1
67592 ZZ91 $6$KB$b2eu/y9a0V3DSk3r8LAhqrblbH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
67593 ZZ92 $6$KB$bEnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
67594 ZZ93 $6$KB$b02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnvzEBPXMKLtdffkpo0JKB6LKw74M9sf6D3JvQy.cbU5BCR76/
67595 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cPIbvR6KGoPMtpf7pbea9JFdfj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
67596 ZZ95 $6$KB$b$qmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RbPyf4IhKFR1fL2xqNM0X1kalRzzhe4jxdspPEuoRMFgoTbblrJ0
67597 ZZ96 $6$KB$bUrzgUnWyaGjoKrg7zK540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
67598 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmlEJKXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
67599 ZZ98 $6$KB$b$eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./
67600 ZZ99 $6$KB$b.n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYlKkvNQEyg1PHCzjmcN8dH7431TL2GvrXjaACBBHnoZx6ugcYkaSrf1
67600 solutions explored
Time elapsed was 854746969314ns or 854.746969314s
ashishshrestha@ashishshrestha: ~/Documents/Assignment$ 
```

10.

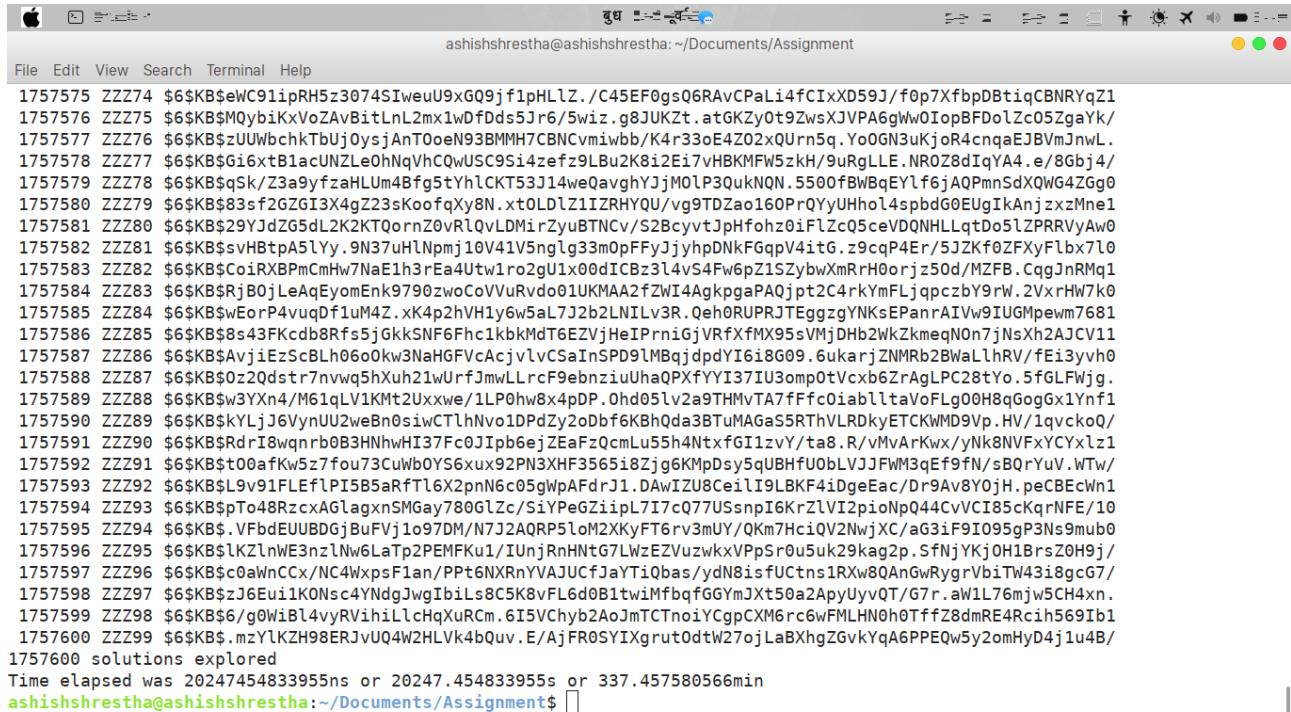
```

Terminal                                बुध 2:25 अपराह्न
ashishshrestha@ashishshrestha: ~/Documents/Assignment
File Edit View Search Terminal Help
67575 ZZ74 $6$KB$bYwf3VmyffG6ira7Gyhz41fg0tBkA6KqimtaWazTMFFxn9It4h5NmmtQfFzo.RC2gY0uYx9Cq8raZZgxYq/mo/
67576 ZZ75 $6$KB$bX2451iLQTFtq049EHsbwLT79vKkyVVn4o8eTG26kEd5g0xK9xh8FV6fk91qP7ldocZhb08qlk8jbscl5G.Vy1
67577 ZZ76 $6$KB$/oi/6/zBFE5d0ZwnQjX8KqfhiycZeS3rttMpVNciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dlls.
67578 ZZ77 $6$KB$bR01Ef5K1Voc6KXNx55ikf70TwVMiPZEPztrNGHBNaf9UwGtUoqnw.4CXCEgW6NsneBm8YYwWpbir5wpqlJl.
67579 ZZ78 $6$KB$bEtgT36YAt8xlpqMgdceBUAngLdYg/hMifqg1XT2CH722xlM2fxJ1ccnXYn.gnGnsYvVPqs0tKqNgBkjwger0
67580 ZZ79 $6$KB$bjsU0fb6Vgy.uFYeY.rSXEB0eAjw0hUxCj7htVsLM6ahexvt3aj4VYdh4nZ3wGrssZtlhbJ7Ecx6Ja9Rw0
67581 ZZ80 $6$KB$bKNA46P2pAMhjb233D801kJupJepIg1slePwZdgCeYwuzNptvnCJ8m6nWDAbHD0IDilAJYwAKUpt7iwTB112.
67582 ZZ81 $6$KB$b093pWA16kSQzyleETk0jK0x69uFQEbz9P.yD4s0YV3oss54B2JFLiWuJQkjm9g451p.CXFQ0LDFcTDn0N0d71
67583 ZZ82 $6$KB$b16CMCMoURkSt0ALmMYBG3HnFOHqYnIUsEzNgYbIB84Nv4CpUXBYnVz9xdkBt08d07TmhFGSKVSwow9ZNZMR// 
67584 ZZ83 $6$KB$b$vyseEGCALa25vo1ntCeKs.CvADKQKpCUG/D./DV0U0PCPJsm1/1nBMsZNF21IGr4p5BeRAwtC76jX07jGB1Z.
67585 ZZ84 $6$KB$b55xu.uAA902HKKvft4DuCyS19eKKTExCa/ZlkDcA8KmDQ/LUU4KfsK8A8pajt4wDVKH2M3ft15X.00ysHPi90
67586 ZZ85 $6$KB$b1Pqgw4F2.75K/QfcSDbEsWk0ieRK6D6KAVQyEoW56.Duj96PdssQG2QxX474/VPYF4W7aoYGe80xIWKMkco.0
67587 ZZ86 $6$KB$b1D/FRKcrM23MBiISi4rjm.DHY3nP109nyZ07459ZXM0RDGj40w0pURZE6n0NWRi3gwRW/NHqaTJLIM.aq070
67588 ZZ87 $6$KB$b98RtAp7wZriHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TxMnZBPO/2uFpPhT9AoSqtBu7lqUjs3V1
67589 ZZ88 $6$KB$b$u9oc6jJpetheted5g0Sbx0M0UUp09rh.y5GuqCc5WTSHy/3J2B3i80lQ/hMMYyOTFXDd9dssrTuqBRO/nPu11
67590 ZZ89 $6$KB$bC0zn7XrcDiw51/tCCxSYBhN4N8h.UE/ziLL1smfyvgbcEf0dS8n3zfHewkqInqg9EG0uXyXYQjHjs/9idY.
67591 ZZ90 $6$KB$b.e.aMgv0H0do1dybMLGEK0DQxyX39mXQz0vGfhKb3z2Rpt14JQH2zTREwCBIdoVp.QkWEUrcRo7EhXN3ps0cJNLG1
67592 ZZ91 $6$KB$b2eu/y9a0V3DSk3r8LAhqrblbH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12HgqppIoqoAT.
67593 ZZ92 $6$KB$bEnFrrd7i7tX8ZCnld/eKc3H/AV.lxky3QEPdTauyKd667Ur4rwtp1bY3Q6oY5gC.MvU5pKuA5p7cqHPu09qC/
67594 ZZ93 $6$KB$b02Fv/5kUDsa9KmGzeZC5a3jV0qnTd3RRnkXqnvzEBPXMKLtdffkpo0JKB6LKw74M9sf6D3JvQy.cbU5BCR76/
67595 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cPIbvR6KGoPMtpf7pbea9JFdfj0p0tRHk.7.zfcTCAUjuav20J8JZb5wBMrt0
67596 ZZ95 $6$KB$b$qmB840ZKwv3t2fgJnYawmuglVBjk5Szq8RbPyf4IhKFR1fL2xqNM0X1kalRzzhe4jxdspPEuoRMFgoTbblrJ0
67597 ZZ96 $6$KB$bUrzgUnWyaGjoKrg7zK540mE5yYKHOnjLUB0fcD4Jjmjw6m0A/1.aq984tnjvwjCC0Rtg/MNg46CFLzyad9f1
67598 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tihRbPT6tqjwauj37zhmlEJKXNpqbfb1VBHLVdGe5411e3NFCNXi10cz6vp2jwKrLb0
67599 ZZ98 $6$KB$b$eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVvWoRvukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./
67600 ZZ99 $6$KB$b.n.Yjw98UBTw/k8Ifvbv5rTozwkjI/uyYlKkvNQEyg1PHCzjmcN8dH7431TL2GvrXjaACBBHnoZx6ugcYkaSrf1
67600 solutions explored
Time elapsed was 870891680057ns or 870.891680057s
ashishshrestha@ashishshrestha: ~/Documents/Assignment$ 
```

## Password Obtain from encrypted password.

```
ashishshrestha@ashishshrestha:~/Documents/Assignment$ ./CrackAZ99-With-Data-multi-threads | grep '#'
#7379    CV78 $6$KB$6SsUGf4Cq7/Oooym9WQN3VKeo2lynKV9gXVxE4HvYy1UFRx.XAye89TLp/0TcW7cGpf9ULU0F.cK/S9CfZn1
#14988   FT87 $6$KB$1VCJQRsKAizZvuTjEqLE./zeAqZ7AdqzTdx5Tob.b0DRGlXOEvkNhuqMorBSvCp4fP0eoNm2wULs3DRAbbrLQ/
#17377   GR76 $6$KB$VKxGV/w3/XgUswkstexjD72Q5jKKSTyxSfIQLktApaQlnYvPfZA4038d1fc4QvWxDc93T4Hzff/kMKgfzFM/
#13065   SA64 $6$KB$xJHmCu7jpWBZlq2AAZUB5ZF8NcJgZkydHbCyfPwy3nE.dj1lSmUxHDLAznwz8ys5L8L9.61NmDyXsyN32r1
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

## Time taken by 3-initial-2digits password.



The screenshot shows a Mac OS X terminal window with the title bar "ashishshrestha@ashishshrestha: ~/Documents/Assignment". The window contains a large amount of text output from a password cracking tool, listing various password candidates and their hashes. The text is too long to reproduce here but follows a consistent pattern of hash length, prefix, and suffix. The terminal window has a standard OS X look with a dark background and light-colored text. The scroll bar on the right side of the window is visible.

```
ashishshrestha@ashishshrestha:~/Documents/Assignment$ ./CrackAZ99-With-Data-multi-threads | grep '#'
#7379    CV78 $6$KB$6SsUGf4Cq7/Oooym9WQN3VKeo2lynKV9gXVxE4HvYy1UFRx.XAye89TLp/0TcW7cGpf9ULU0F.cK/S9CfZn1
#14988   FT87 $6$KB$1VCJQRsKAizZvuTjEqLE./zeAqZ7AdqzTdx5Tob.b0DRGlXOEvkNhuqMorBSvCp4fP0eoNm2wULs3DRAbbrLQ/
#17377   GR76 $6$KB$VKxGV/w3/XgUswkstexjD72Q5jKKSTyxSfIQLktApaQlnYvPfZA4038d1fc4QvWxDc93T4Hzff/kMKgfzFM/
#13065   SA64 $6$KB$xJHmCu7jpWBZlq2AAZUB5ZF8NcJgZkydHbCyfPwy3nE.dj1lSmUxHDLAznwz8ys5L8L9.61NmDyXsyN32r1
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

```
1757575 ZZZ74 $6$KB$bW91ipRH5z3074SIweuU9xGQ9jf1phLLZ./C45EF0gsQ6RAvCPaLi4fCIxXD59J/f0p7XfbpDBtiqCBNRyqZ1
1757576 ZZZ75 $6$KB$M0ybiKxVoZAvBitLnL2mx1wDfDs5Jr6/5wiz.g8JUKzt.atGKZy0t9ZwsXJVPAGlw0IopBFDo1Zc05ZgaYk/
1757577 ZZZ76 $6$KB$zUWbchKtBuj0ysjAnT0oeN93BMHH7CBNCvmiwbB/K4r33oE4Z02xQUr5q.Yo0GN3uKjor4CncqaEJBVmJnwL.
1757578 ZZZ77 $6$KB$Gi6xtBlacUNZLe0hNqVhCQwUSC9Si4zefz9LBu2K8i2Ei7vhBKMFw5zkh/9uRgLLE.NR0Z8dIqYA4.e/8Gbj4/
1757579 ZZZ78 $6$KB$gSk/Z3a9yfzaHLUm4Bfg5tYhLCKT53J14weQavghYJjM0lp3QuKnQN.5500fBWbQeYlf6ja0PmnSdXQWg4ZGg0
1757580 ZZZ79 $6$KB$83sf2GZG13X4gZ23sKoofqXy8N.xt0LDlZ1ZRHQU/vg9TDZao160PrQYyUHhol4spbdG0EUgIkAnjzxzMne1
1757581 ZZZ80 $6$KB$29YJdZG5dL2K2KT0rnZ0vRLqvLDMirZyuBTNCv/S28cyvtJpHfohzoFlzC05ceVDQNHLLqtD05lZPRRVyAw0
1757582 ZZZ81 $6$KB$svHBtpA51Ly.9N37uHlNpmj10V41V5ngl33m0pFFyJjyhpDNkFGqpV4itG.z9cqP4Er/5JZKf0ZFXyFlbx7l0
1757583 ZZZ82 $6$KB$CoiRXBPmCmHw7NaE1h3rFa4Utw1ro2gU1x00dICBz3l4vS4Fw6pZ1SzbwXmrH0orjz50d/MZFB.CagJnrMq1
1757584 ZZZ83 $6$KB$RjB0jLeAqEyomEnk97790zwCoVVuRvd01UKMAA2fZWI4AgkpgPAQjpt2C4rkYmfLjqpczbY9rW.2VxrHw7k0
1757585 ZZZ84 $6$KB$wEorP4vuqDf1uM4Z.xK4p2hVH1y6w5aL7J2b2LN1Lv3R.Qeh0RUPRJTTeeggzgYNKsEPanrrAIvW9IUGMpewm7681
1757586 ZZZ85 $6$KB$8s43Fcdb8Rfs5jGkkSNF6Fhc1kbkMd76EZVjHeIPrniGjVRFxFMX95sVMjDhb2WkZkmeqN0n7jNsXh2AJCv11
1757587 ZZZ86 $6$KB$AvjiEzScBLh06o0kw3NaHGFVAcjvlvCSaInSPD91MBqjdpdYI6i8G09.6ukarjZNMRb2BWallhRV/fEi3vh0
1757588 ZZZ87 $6$KB$0z20dstr7nvvq5hXuh21wUrfJmwLrcf9ebnziuUhaQPXFyYI37IU3omp0tVcx6zRgAgLPC28tYo.5fGLFWjg.
1757589 ZZZ88 $6$KB$w3YXn4/M61qLV1KMt2Uxxwe/1LP0hw8x4pDP.0hd05lv2a9THMVTA7fFfc0iabltaVoFlg00H8qGogGx1Ynf1
1757590 ZZZ89 $6$KB$kYLj36VynUU2weBn0siwCTlhNvoIDPdzY20dbf6KbhQda3BTuMAGaSSRThVLRDkyETCKWMD9Vp.HV/lqvcko0/
1757591 ZZZ90 $6$KB$RdrI8Wqhrb0B3NhwhHI37Fc0JIpbezejZeaFzQcmLu55h4NtxfGI1zvY/tas.R.vMvArKwx/yNk8NVFxYCYxlz1
1757592 ZZZ91 $6$KB$100afKw5z7fou73CuWbOYS6xu92PN3XHF356518Zjg6KMpdsy5qUBhfU0bLVJJFWM3qEf9fN/sB0rYuV.WTw/
1757593 ZZZ92 $6$KB$L9v91FLPI5B5aRftL6X2pnN6c05gpAfdrJ1.DAwIZU8CeilI9LBKF4iDgeEac/Dr9Av8Y0jH.peCBEcWn1
1757594 ZZZ93 $6$KB$pTo48RzcxA6lagxnSMGy780glZc/SiYpeGziplL7I7CQ77USSnpI6krZLVI2piNpQ44CvVIC85ckqrNFE/10
1757595 ZZZ94 $6$KB$.VFbdEUUBDGbjFuFVj1o97DM/N7J2AQR5l0M2XKyFT6rv3mUY/Qkm7HciQV2NwJXc/aG3iF9I095gP3Ns9mub0
1757596 ZZZ95 $6$KB$1KZlnWE3nzlNw6LaTp2PEMFku1/IunjRnhntG7LwEZVuzwkkVPpsr0u5uk29kag2p.SfNjYKj0H1BrzsZ0H9j/
1757597 ZZZ96 $6$KB$c0awhCCx/NC4WxpsF1an/PPt6NXRnyVAJUCfJaYTiQbas/ydN8isfUctnsIRXw8QAnGwRygrVbiTW43i8gcG7/
1757598 ZZZ97 $6$KB$zJ6Eu1kKOnsc4YNdgJwgIbil8c5K8vFL6d0B1twimfbqfqGGymJxt50a2ApyUyvQT/G7r.aW1L76mjw5CHxn.
1757599 ZZZ98 $6$KB$6/g0Wibl4vyRVih1llchqXuRcm.6I5VChyb2AoJmTCTnoiYCgpCXM6rc6wFMLHN0h0TffZ8dmRE4Rcih569Ib1
1757600 ZZZ99 $6$KB$.mzYlkZH98ERJvUQ4W2HLVk4bQuv.E/AjFR0SYIXgrut0dtW27ojLaBXhgZGvkyQa6PPPEQw5y2omHyD4j1u4B/
1757600 solutions explored
Time elapsed was 20247454833955ns or 20247.454833955s or 337.457580566min
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

## Time taken by multi-thread program.

1.

```
Terminal 8:55 पूर्ण
ashishshrestha@ashishshrestha:~/Documents/Assignment
File Edit View Search Terminal Help
33755 MZ54 $6$KB$bYltehxCyUgGijPPi0US7XobP2qbIJtL319w1G1Ejz.RX3TNG8uCo3XdfpLKVf0BW5fVNx5RwUdWD5GP3.b5.
33756 MZ55 $6$KB$b1t1Ky5n0PUyz4N8UWP4Pk5N/Uw3o2pdf3.6IZCrkVP9Hae0PtXN3lR8MlP8rzDGD/d1ptxIBWyptrRRDmN301
33794 ZZ93 $6$KB$b0zFv/5kUDsa9KmGZeZC5az3jV0qnTd3RRnkXqnvEBPXMKlTdffkp00JKB61kW74M9sf6D3JvQy.cbu5BCR76/
33633 ZY32 $6$KB$b62177xV5bmAJU3Y0ceFNCHXB300Lc91odVaGYI8W70oLxveey02aIKBo3/71VS0du7eEtib.SAacHggGb1
33757 MZ56 $6$KB$b4Y3A01Wz54K0C4uw0I44e/kNys6Zlsw75ipZtKBpNw6oFJWF0z7.sINMAqJYr4V7gnHw7K/eS70SXZH5c0pL0
33758 MZ57 $6$KB$b2ztFThrb700hq52g26CZeav0AzVq0zYFTkFL.outcAib.e3AdsmV4f4yDtNwjTrzysAWCBLYbrQy40zuof8GXZr.
33795 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cP1bvr6KGoPMtpf7pbea9JFdj0p0tRKh.7.ZfcTCAUJuav20J8Jzb5wBMrt0
33634 ZY33 $6$KB$bMHM4BwdsJeALAYzXgeEvILY7sefBytk.nshSDJv0mZHnEhDwdUkJaJ/Mw8czRuTT4yDwmnqYh8itFw41.7wiP1
33759 MZ58 $6$KB$bERgFrJrbm9hVoncIohu5279TAjEl.6hyhbpsKHNkd8ZIInGvUY.wGoyTUTUdofd8sj6hk.Eii0GKVtqubV67PG.
33796 ZZ95 $6$KB$bqmB840ZKw3t2fgJnYawmuglVbjkSzq8RPyf4IKhKFRflf2XqNM0X1kalRzzhve4jxdSpPEuoRMFgoTBblzrJ0
33760 MZ59 $6$KB$bMKMLRgLdhWtvW8dyj22PuflegmqddCMF0Iz02wxu0iNwjuEpG7I5vB3qUPFBpVse8MPWpI0ZJwCs1r0R6DW.
33635 ZY34 $6$KB$b.Ed8nmXm02L3MsNStkWJfj2Up0/8GQ/zNPv074wErVbctwkEmvwLqbP6ZtVLBhw0WAw6CxXavG60dLMTB4m0
33761 MZ60 $6$KB$bJHF/HanwfLnGv4NHI5zQEL.bnEhDw5u8L0/4c4jUN0Treh5eyYi.03giAefvSs0Pw6pB6401rGqicfvXzD0
33797 ZZ96 $6$KB$bURZgUmWyaGjoKrg7z5k40mE5yYKHOjLUB0fcD4j3mjWw6m0A/1.aq984tnjvjCC0RTG/Mng46CFLZyad9f1
33762 MZ61 $6$KB$b0vc5PvQBCDRFFsoya0NvngJ.xCmp2cmkXhpbyk1ANIIyM5Ei60VRl/7zcHnqDBJBjCvPsOsiaAE0/CRqxW.
33636 ZY35 $6$KB$bSpAkuSlrFup6Um5kl2DEqW/vEqxD5L2726.VNiI80aGUQE6zLm9f02U6PCm/rfzqAYdT1bQD91.UMm3kFZT1
33763 MZ62 $6$KB$bEnQ/LC5s/nbka9CqAy2V2XgedSm0m.v066arfIHvifSVWdnIeXrgamZ6Njg0p0VKClnb2jjNs0EmArf3vXEG.
33798 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tIhRbPT6tQjwauj37zhmLEJKXNpqfb1VBHLVdGe5411e3NFcNXi10cz6vp2jwKrLb0
33764 MZ63 $6$KB$bSmkKAASw.QIdMcEBh5bAXWB411Y70y306FvfPN/kYMoZ94VJGHsAvYp0xw4w7l32NSzx4Ci0KKZ004pUIw01
33637 ZY36 $6$KB$b5e766p2NMov81kYK8/CwrvGRHrLSQd7/5ro6vTsZxFgeYjZMfpWDUI1qgbU2mBZws6u9aTDTTdfy/GnBVccJ0
33765 MZ64 $6$KB$b0SDXK9nWTiyHABk2v31ATVPMBeYVAxvICAMUoDAgD2y9.gr8w417cJ9TCXG429Mei0Dr4GQ3QJXXcoLobob9A/
33799 ZZ98 $6$KB$beve8v4J8QPlzn9U0BMugDaR0W7VnUpY48lvc.09qaCaVWwOrUkxmPuP1Mf320SPjtFzd6 zugsi9129QNb./
33766 MZ65 $6$KB$bJlevuW6e5Fdf8shX6rhdL8vmdIi08Lr2dbp1Zy0p07ZyAs1zBYDzAFXygWrBvvWngizp92/2lqiVkmG77nm1
33638 ZY37 $6$KB$b4uCQ3uKs0b/FfR4z05vWarvPl0Uqiyz0yBFGBtWFNayGS7c5MkWkPbYagn/qZs1b0frruuR90rM3/YFhx5WiP0
33767 MZ66 $6$KB$b9tyhBrUu0.u1cE1SX/ZXXNDBuov.Pb1sKjQlfssPPs.oCffstkJnWvJErutH9CjCSRsIPR07f9aIQmiH4lney/
33800 ZZ99 $6$KB$b.N.yjw98UBTw/k8Ifbvb5+TozwkjI/uYlKkvNQEyglPHCzjmcN8dH7431TL2GvrxJaACBBHnoZx6ugcYkaSrf1
33800 solutions explored
Time elapsed was 424101145135ns or 424.101145135s or 7.068352419min
ashishshrestha@ashishshrestha:~/Documents/Assignment$
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2.

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Terminal 9:03 पूर्ण
ashishshrestha@ashishshrestha:~/Documents/Assignment
File Edit View Search Terminal Help
33775 ZZ74 $6$KB$bYf3VmyffG6ira7Gyhz41fg0tBkA6kqimtaWAZTMFFxn9It4h5NmmtQffZo.RC2gY0uYx9Cq8raZZgxYq/mo/
33776 ZZ75 $6$KB$bX2451IQTftq049EHsbwLT79vXkyVVn4o8eTg26kEd5g0Xk9xh8Fv6fk91qP7ldocZhQb08qlk8jbscl5G.Vy1
33777 ZZ76 $6$KB$b/oI/6/zBFE5d0ZwnQjX8KqfhicycZeS3rttMpVnciVowhs0bdv2uZgBxZekV4xsDmQX6j6RGYs7mYf1WN/dLLS.
33778 ZZ77 $6$KB$bRQ1Efpp5K1Voc6KXNx551kf70tVMPZEPspztrNGHBNaf9uWgtUoognw.4CXCEgW6NsneBm8YyWpbir5wpqlj1.
33779 ZZ78 $6$KB$bTgT36Yat8xlpqMgdceBUAngldYg/hMifqg1Xt2Ch722Xlm2fxJ1ccnXyn.gnGnksYYVpqstqKqNgBkqjWger0
33780 ZZ79 $6$KB$bjsu0fb6Vgy.uFyeY.rSXEB0eAjw0hUxCj7htVslM6ahexv3taj4VYdH4nZ3WgrSsZtlFAMZLhbJ7Ecx6Ja9RW0
33781 ZZ80 $6$KB$bKNA46P2pAMhjb233D8Q1kJupJepIg1s1ePwZdGceYwuzNptvnCj8m6nWdAbh0DIDiLAJYwaKupt7iwTbi12.
33782 ZZ81 $6$KB$b093pWA16kS0zyleETk0jkoX69uF0EB297p.yd4s0YV3oss54B2JFLiWuJQkjmg9451p.CXF00LDfCTDn0NoD71
33783 ZZ82 $6$KB$b16CMCMoUrKst0AlmMYB3HnF0HqYnIUsenZNg6YbI84Nv4CpUXBynVz9XdbkT08d07TmhFGSKVSwow9NZMR//.
33784 ZZ83 $6$KB$bwyseEGCALa25V01ntCeks.CvADK0pkCUG.D./DV0U0PCPJsm1/1nBmsZnf21IG4p5BeRAwtC76jX07jG81Z.
33785 ZZ84 $6$KB$b55x.uAA902HKKvfT4DuCys19eKKTExCa.ZlkDcA8KmDQ/LU4KfsK8A8pqjt4wDVKH2M3ft15X.00ysHPI90
33786 ZZ85 $6$KB$b1Pqgw4F2.75K/OfcsDbEswk0ieRk6D6KAQy0ew56.Du96Pdss0Q20X474/PVF4W7aoYGem80xIwKMKco.0
33787 ZZ86 $6$KB$b1d/FRKcrM23MBiISi4rjm.DHY3nP109nyhZ07459ZXM0RDGj4oW0pURZE6oNVWrI3gwRW/NHqaTJLiM.aq070
33788 ZZ87 $6$KB$b98RtAp7wZrIHHQAD62owLtx01Mb/BD2s155ojlyKCR8vB6PGkF3TxMnZBp0/2uFpPh9AoSqtbu7lqUjs3rV1
33789 ZZ88 $6$KB$b096jJpetHtted5gbs0Xm0UUp09rh.y5GuqcCcTS/3J2B3i801L/hmxMy0tFXDd9dSsrTuQBR0/nPui11
33790 ZZ89 $6$KB$b0zn7XrcDIw51/tCCsVxyBhN48h.UE/zLlIsmfyvgbcEf0dS8m3ZfHnewKqInq1g9EG0uXYXYQjHjs/9idy.
33791 ZZ90 $6$KB$b.aMgv0Hdo1dybMLGEKQDxYx39mXQzv0GfhKb3z2Rp14JQH2zTREwCbiDoV.pQwEurcRo7EhXN3ps0cJNLG1
33792 ZZ91 $6$KB$b2eu/y9a0V3Ds3k3r8LahaqRiblH6CpkLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6TikQwmQ9C12H6qppIqoAt.
33793 ZZ92 $6$KB$bEnFrrd7i7tX8ZcnLdeKc3H/AV.1xky30EPdtauykdg667Ur4rWwtp1bY306Y5G.C.Mv05pkua5p7cqHPu09cC/
33794 ZZ93 $6$KB$b0zFv/5kUDsa9KmGZeZC5az3jV0qnTd3RRnkXqnvEBPXMKlTdffkp00JKB61kW74M9sf6D3JvQy.cbu5BCR76/
33795 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cP1bvr6KGoPMtpf7pbea9JFdj0p0tRKh.7.ZfcTCAUJuav20J8Jzb5wBMrt0
33796 ZZ95 $6$KB$bqmB840ZKw3t2fgJnYawmuglVbjkSzq8RPyf4IkHkFRf1f2XqNM0X1kalRzzhve4jxdSpPEuoRMFgoTBblzrJ0
33797 ZZ96 $6$KB$bURZgUmWyaGjoKrg7z5k40mE5yYKHOjLUB0fcD4j3mjWw6m0A/1.aq984tnjvjCC0RTG/Mng46CFLZyad9f1
33798 ZZ97 $6$KB$beve8v4J8QPlzn9U0BMugDaR0W7VnUpY48lvc.09qaCaVWwOrUkxmPuP1Mf320SPjtFzd6 zugsi9129QNb./
33800 ZZ99 $6$KB$b.N.yjw98UBTw/k8Ifbvb5+TozwkjI/uYlKkvNQEyglPHCzjmcN8dH7431TL2GvrxJaACBBHnoZx6ugcYkaSrf1
33800 solutions explored
Time elapsed was 428928177644ns or 428.928177644s or 7.148802961min
ashishshrestha@ashishshrestha:~/Documents/Assignment$
```

3.

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Terminal
ashishshrestha@ashishshrestha: ~/Documents/Assignment
File Edit View Search Terminal Help
33704 ZZ03 $6$KB$Dpc.MdCytEI5Cf5v8ix52RUMAbPN0D3UQAY0GmVuVbXSeAqD8BtyNu619HRCtI8lN5LwHEPkFVWXBtMUGbB.
33582 ZX81 $6$KB$u0lBsGxlT8iVgYyKa5NaalHmn/hN6nCHuipfd7FTf85YSDhXyUwvgo0cVJv6tMniYF/dYNpx2sUgtNh930n80
33789 ZZ88 $6$KB$u09c6jJpetHtted5gSbx0M0UUp09rhn.y5GuqCcSWTSHy/3j2B3i80l0/hMXMYoTFXDd9dsrtTuQBR0/nPu11
33790 ZZ89 $6$KB$Cozn7XrcDIw51/tCCxSVYBhN4N8h.UE/zlLIsmfyvgbcEfQdS8n3ZfHnewKqInq1g9E60uXyXYQjHjs/9idy.
33705 ZZ04 $6$KB$VN5mRA6ssvcclCBAzeFvWxyfsfNBjutoKQ8wUl746BZIMiLemc8j5IsIimoNkVgLvkJSbs5Eev9swcLy_sn/
33583 ZX82 $6$KB$YheTZ0CsdtTLAPCyXkOzlbYpEURdvL5JNrwjWXBVdtKM7/N7ZVXLenDYszCqSMqh.1GME3Va8.Y4K7ymXZios0
33791 ZZ90 $6$KB$e.aMgv0H0d1dybMLGEK0DxyX39mX0zv0GfhKbz2Rpt14JQH2zTREWCB1doVp.QkWEUrcRo7EhXN3ps0cJNLG1
33706 ZZ05 $6$KB$2RQwizwHN66DlbRH/cbz8mv1j7UemCcrS4b4MEvNeHuI/lXR7u00S7rDIKjJ9WjHm/dku/w0FslNI2ebBYd.
33584 ZX83 $6$KB$GILKt.8ND04T5hWexPQfxKsmgF40LPMuCuDQEbbHxxropcJw3is/AqEGA.uv8jAdUmemmXfSJ5M8rFDu00f53/
33792 ZZ91 $6$KB$b2u/y9a0V3DSk3r8LAhqrblH6CpkhLYC9CwUgWe4.QxqMd5bbEvau9gahVvF6Ti9kQWmQ9C12HGqppIoqoAT.
33793 ZZ92 $6$KB$bEnFrld7i7x8Zcnld/eKc3H/AV.lx930EPdTauyKd667Ur4rwtp1bY306y5gc.MvU5pKuA5p7cqHPu09qC
33585 ZX84 $6$KB$b00g7UKz67.jrlsJ01zKQu0K/W4UDwf59QeeiA6olBnaul1GoeFET1UlyMegev7yXL0DCp5.T7WMNHJWCXN/
33707 ZZ06 $6$KB$b5eIrkyJw4fWs.6b4Hbvn/s0OUFXPLCCQd55CSYcu3BnkUZedA5taJXYFesFvLuM9YmKc5TgaskNg/ByDR/
33794 ZZ93 $6$KB$b0zFv/5kUDsa9KmGZeZC5az3jV0qnTd3RrnkXqnzbEPBXMKL1dfffk00JKB61KW74M9sf6D3jvQy.cbu5BCR76/
33795 ZZ94 $6$KB$bZafET5X77msPbHed1s7cRTU/2cPIbvrK6GopMtpf7pbea9JFdj0p0tRHK..7.zfcTCAUJuav208JZb5wBMrt0
33586 ZX85 $6$KB$b0R5txWVBFvJwoQ2BhNgELC/206BkBBV8Hx/h0IawRqaP2rK3TfWhqk/I175vprpsPwjkonNMvB4YxyW7vt1
33708 ZZ07 $6$KB$b0Ie0iF9TbKeU0nDcKzf1Kh9QeBIR/dMSPGeqKAOPInh0lCMS0RIIs8x1w6/vSXet0yqMwNq9CXBvVnvW0y2t.
33796 ZZ95 $6$KB$bqmB840ZKwv3t2fgJnYawmuglVBjk5zq8RpByf4IKhKFR1f12xqNMOX1kalRzzhve4jxdSpPEuoRMFgoTBblzrJ0
33587 ZX86 $6$KB$b4nbEnznmTYotVrpIE5Xg5jKakrNmEjRwY4FyUoact6en49ZVR2A0/W9LiaAdSLTUz32j0BrLWI/zSOK8C0vVeD.
33797 ZZ96 $6$KB$b0rzgUnWyaGjoKrg7zK540mE5yYKHOnjLUBQfcD4jimJwW6m0A/1.aq984tnjvwjCCOrtG/Mng46CFLZyad9f1
33709 ZZ08 $6$KB$b0h8a70nq.KrqUudhcx1NaumDqj/3Tt4voiVt.HsySLpFWkJhlshEq50vow7dpnvwthpxOyjIBAM2MvuGxn/
33798 ZZ97 $6$KB$b0l6hksBWE0YCD/FxJN0tIhRbPT6tQjwauj37zhmLEJKxNpfb1VBHLVdGe5411e3NFcNx10cz6vp2jwKrLb0
33588 ZX87 $6$KB$wdVAqM21Wq0w.vUhZUuceED9qPsfx.6frwNWE08ss7eyo.IdQNI8km2GZFEt3.1Ql9fmHlQieuof.KcDnCBC9/
33710 ZZ09 $6$KB$b0UpHBABG0aCCRAC1jz.JbJylf4zCHDLQAN.IhPxr1lKDRS30NHaead7565jrcRyKx7fveyOcijd.w5aJHg5G/
33799 ZZ98 $6$KB$b0eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVWwRoRVukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./
33800 ZZ99 $6$KB$b0n.Yjw98UBTw/k8IfvBv5tTozwkjI/UyYlkvNQEyg1PHcZjmcmN8dH7431TL2GvrxJaACBBHnoZx6ugcYkaSrf1
33800 solutions explored
Time elapsed was 428028800344ns or 428.028800344s or 7.133813339min
ashishshrestha@ashishshrestha: ~/Documents/Assignment$ 
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4.

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Terminal
ashishshrestha@ashishshrestha: ~/Documents/Assignment
File Edit View Search Terminal Help
33796 ZZ95 $6$KB$bqmB840ZKwv3t2fgJnYawmuglVBjk5zq8RpByf4IkHkFR1f12xqNMOX1kalRzzhve4jxdSpPEuoRMFgoTBblzrJ0
33797 ZZ96 $6$KB$b0RzgUnWyaGjoKrg7zK540mE5yYKHOnjLUBQfcD4jimJwW6m0A/1.aq984tnjvwjCCOrtG/Mng46CFLZyad9f1
33780 MZ79 $6$KB$bVhi9yizG4zL7b9E81415I4zYA1glNRNPQVay2jT4V4C0cu1II1mHdl4f00zKir00Eg5686UA0F0d30LRPTHy.
33798 ZZ97 $6$KB$b0l6hksBWE0YCD/FxJN0tIhRbPT6tQjwauj37zhmLEJKxNpfb1VBHLVdGe5411e3NFcNx10cz6vp2jwKrLb0
33781 MZ80 $6$KB$b03nj2XQPh4RTAFJcdlxhrlzVXMdleE9y682xg30K1Rw9mc8jpmds/s1J8xUe3xtbGjeZhDFMb1LltDvypyB1
33799 ZZ98 $6$KB$b0eve8v4J8QPlznp9U0BMugDaR0W7VnUpY48lvC.09qaCaVWwRoRVukxmPuwP1Mf320SPjtFzd6zugsi9129QNb./
33782 MZ81 $6$KB$b0dqsfjsgsPce6wnCylmLxXg9HNRvY9t2KvDRef09s0BSn0FqTR/0HKJ82sK/TSAqdZ/50.p89nxz50d0T.
33800 ZZ99 $6$KB$b0n.Yjw98UBTw/k8IfvBv5tTozwkjI/UyYlkvNQEyg1PHcZjmcmN8dH7431TL2GvrxJaACBBHnoZx6ugcYkaSrf1
33800 solutions explored
33783 MZ82 $6$KB$bhfTsEYQySde/IQ5J1Lxb4saXNn7WLihsdBcGz6uEGhhGabd/hAFGK/UqsWkIn4q2waRGGW6l8j/iPAqKKCXh1
33784 MZ83 $6$KB$b0rvar15dJG.KkhS1cA51ciHwpAuHwUP0nzh.7vSJ7s77PC6.56LlfMs5dFnV34Hgq1igteYxeGvqliliZqw1.
33785 MZ84 $6$KB$bxx7B2U0UJLdbLLr0/vKISG5CE4deqh52dg2BRIFCsg/ZtQcqcFOEsH1H1dNj3b618k5f8AR.czDATZjIapnQ01
33786 MZ85 $6$KB$b.v2k060N840N0cwKhLFVhyyNfZe600Dj9bmalYuf3BrrP1Ra2B2TNCakYpcgSnX2iwGpV0eQg9e6Lyg/ky1
33787 MZ86 $6$KB$b0ce3GrQiuHx19I808lxBwWPxEZ9HsRmvD2Hzu7IBzgBHCxZdj5wHATirVnwj.1Ks/e/5N01FH8jukKy7Pgb9.
33788 MZ87 $6$KB$b0ie9jxPZYfmoUXfEHd5jYmjzJps080kaxd.n0Cjb.v0n2St.uEd.4CcB9g0hTmEZzT/FON0xaIsvwU6.sN./
33789 MZ88 $6$KB$b0xZb0e7YTMvH15b0d8M8Pmpe2Yrl5Jus9dh8zkkp0tPZHNS5Bhm.5d5nDn6VF39XuRDkZNM0EtUp01
33790 MZ89 $6$KB$b0qe2317Y5uf0cU4M/0BWVfEdnTgLGij0tbA0E70sra0xR1/NR3vFj4Z/sMYA1Pj6ztPAE82fenkBQre.oK6Eo/
33791 MZ90 $6$KB$b.3U7tmqRN42wNnJdp0Cw8kcg5XRzaenkswAVbkHhN0DXaIEx2f5hab6jnRUXqvuvtdM1iyL20sP/2GTP4FP.
33792 MZ91 $6$KB$b0cvYtwntJtvPftmQ5NlcQjwdJIp6.FXUx0p9z9H2ifLC5x.q70K15HGSXePoW/V5E9KL2Hllx0pRkQkWYCXUHii1
33793 MZ92 $6$KB$b0q90mH9Ywv55CkA0v5/LrLM.gASrpxWYohMtUw250sz.Hw1k1Iqxbk1tvditriYRNR7mbzQziel5Ei0
33794 MZ93 $6$KB$b0eqPP61.qRm90d0dtFx5rd3B0j1/s3o58ij/ng4V74V5Z4JQsvK1My6Sh7do2wkGgJo5xG6uhN7vBGHYHc./
33795 MZ94 $6$KB$b0M0xz1nDcN.a/wede0CxXfgzX6EPIDj7gKhkrNgpt7dhMDHif7M.HUFly/ud3a0fu9yrf/q/PAN9m7McV8fPi0
33796 MZ95 $6$KB$b0Z39okrD6ZwQToJaEPGoeYXAmnZCrJv6F/78YFipv37B8ITp4PHwsn8saufePzybq5h9EcGymVLF1Iz.hkpg/
33797 MZ96 $6$KB$b0tKrxhMmUJUUyVgcae7i0vRuJ6m3duZzMP4b32pP4M3dfFgnfh162auHcObz2ASGLISYqxcUR2JiJLJUcA0
33798 MZ97 $6$KB$b0h8D73lfK7wBS0D4iYSKd3EgT0R/Vo96ZPdY8iaEcZU3zcft7bd/0HU1//zKnZyJ2Vdp534.4H51GVjwxFu1
33799 MZ98 $6$KB$b045Tt017zurXaqIpfRobVrxkli.JG1tXa7uFL29gR7vj6Lfym33CR5jrtQzLzoe8q1pVKEth/1ACnd1E2vtCx7.
33800 MZ99 $6$KB$b0k.Aq1ZKbJdJrx3YnvjqJo0XGpzHReXwFIQ9ccoLEZ1kCXFnvMVFJWR2nFpXQkz1sdbPAAmZmUx0Dza58VfJ1
Time elapsed was 426398617337ns or 426.398617337s or 7.106643622min
ashishshrestha@ashishshrestha: ~/Documents/Assignment$ 
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5.

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ashishshrestha@ashishshrestha:~/Documents/Assignment$
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File Edit View Search Terminal Help
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33774 MZ73 $6$KB$bpb6vka2Iuc8l/u6PA3Yl4CG3l9gk6bwh/Fd8uGI0eksAfKA7S7YTJet0qphbxP1bbtJFxN2Mu6kTfJmLkoVu0
33775 MZ74 $6$KB$v0QGruboVwJp5JUQyj0eZX42qyf4HDkshay4jNaQvcQ5DAQ/S.t2EPSTSScuvqvEuhn6cjvnQMJ83JUs0.Bthb0
33776 MZ75 $6$KB$Dz8kP.U.08z14T2Hco.6DGx328kFNQZ053YmhnbGhZ8RILcrVpI6m6kF7ZIq/BHKKUOGajZqP20w3h6hjg00
33777 MZ76 $6$KB$jSh0rfzN0QH2SojHRA3.GBwyLfu5TIVGiPP8/yghbh9LRE2I8lk8tCIqR9nVY2i0J1PfkLm2m.cm2EnradEY.
33778 MZ77 $6$KB$bssCylGL394iXS/reMbzhDhsToVobHzB1x8PjxpqYYtYx054cgNPkqij4ziAe0HYelUpTsYPrnEb.29ERqlIhx.
33779 MZ78 $6$KB$b3kDvlwx7Z0XhfHAgyNxcC8WmEgjjS5TiP2aVXPYvh014EvCUExuVUjam3Cw9.f3rkS03oY6zJ0mTYIbwjMdCs1
33780 MZ79 $6$KB$bVHi9yjZG4zL7b9E81415I4zYA1gLNRP0VqAY2jT4V4c0cu11I1mHd14f002KirR00Eg5686UA0F0d30LRPTHy.
33781 MZ80 $6$KB$b03nj2XQPTh4RTAFJcdxlhrzVXMdlE9y682xg3QK1RW9mc8jpmds/s1J8XuE3xtbGjteZhDFMblLltDvyptB1
33782 MZ81 $6$KB$b8dqsfjsgsPce6wnCylhLxGgHNRV9t2kDReF09sQBsn0FqTR/0HKJ8zK/dTSAqdZ/50.p89nxz50dQT.
33783 MZ82 $6$KB$bHtsEYQySde/IQ5JlXb4saXNn7WLihsdcbGz6uEGhGGabD/hAFGK/UqsWkIn4q2waRGGW6l8j/iPAqKKCxu1
33784 MZ83 $6$KB$bR0var15dJG.KKhs1CA51ciHwpauhAwUP0nzh.7vSJk7s77PCG.561Lfms5dFnV34HgqiligeYxeGvqliiZqw1.
33785 MZ84 $6$KB$bxx7B2UJLDblLr0/VkISGC5E4deqh52dg3BRIFCsg/ZtQCqpcF0EsH1H1dNj3b6i8k5f8AR.czDATzJianp0Q1
33786 MZ85 $6$KB$bV.2vk060N84N0cwkhLVHgYyynYFze600DJB9malYuf3BBrP1Ra2BzTNCakYpcgSnX2iwGpVoeQg9e6Lyg/kY1
33787 MZ86 $6$KB$bmeCi3GrQiuHx19I808lxBlWPxEZ9HsRMvD2Hzu7IB3gBHCxZdj5wHATirVnwj.1Ks/e/5N01FH8jukKy7Pgb9.
33788 MZ87 $6$KB$bie9jxPZYfm0UXfEHd5jyjmjZjps08kaxD.n0Cjb.vn02ST.uEd.4Cc9g0hTmEZzT/FON0XaiSvWU6.sN./
33789 MZ88 $6$KB$b8xzBoeIN1kfFuT7YVmH15beMuD8MPe2Yrl5Jus9hd8zkkPP0tPHNSBhn.5d5nDn6VF39XuRDKZNMOEtUp01
33790 MZ89 $6$KB$bqe2317Y5Qfc4M/QBWVfEdnTgLGj0t2AQE7Qs0rax1/NR3vFj4Z/sMYA1Pj6ztPAE82fenkBQre.oK6Eo/
33791 MZ90 $6$KB$b.3U7tmqRN42wNnJdp0Cw8kcg5XRzaenksWAvgkHNMQDXIAEx2f5hab6jnRUXqvvutd9M1iyL2oSP/2GTP4FP.
33792 MZ91 $6$KB$bVcYtnJtvPftmQ5NlcQjwdJIp6.FXuXQp9z9H2ifLC5x.q70K15HGSXePOw/V5E9KL2Hllx0pRKQkWYCXUHii1
33793 MZ92 $6$KB$bMq90mH9Yw55CKa0v5/Lr.rLM7.gASrxpWYohMtU250szh.Hw1K1Iqxbk1itvditriYRNR7bmbzQziel5Ei0
33794 MZ93 $6$KB$bPeqPP61.qRm90d0dtFX5dr3B0bj/s3058ij/nG4V74V5ZR4JQsvk1My6sh7doJ2wkGgjo5x66uhN7vBGHYhc./
33795 MZ94 $6$KB$bMQXziNDcN.a/wede0CxxfgzX6EPIDj7gKhkrNgpt7dhMDhif7M.HUFLY/ud3a0fuF9yrf/q/PAN9m7McV8fPI0
33796 MZ95 $6$KB$bYZ390krD6ZwQToJaEPGoeYXAmnpZCrJv6F/78YFipv37B8ITp4PHWsn8saFuPzybq5h9EcGymVLF1Iz.hkpG/
33797 MZ96 $6$KB$bdtKrxhMmUUUyVgcae7i0vRuJ6m3duZzMP4b32p4M3DfdFgnfh162auHcQbs2ASGLISYqxcUR2JiJLJUca0
33798 MZ97 $6$KB$b8Du73lfK7wBS0D4iYSKd3cf7TbD/0HU1W//zKnZzYj2vDp534.4H51GVjwxFu1
33799 MZ98 $6$KB$b45Tt017zURxaqIpfRobVrxkli.JG1tXa7uFL29gR7vj6lyfm33CR5jrtQzLzeo8q1pVKEth/1ACnd1E2vtCx7.
33800 MZ99 $6$KB$bz.Aq1ZkbjdJrx3YnvjqJo0XGpzHReXwFIQ9ccoLEZ1kCFnvMVDFjWR2nFpQkz1SdbPAAmZmUx0DzaS8Vfj1
Time elapsed was 432247245291ns or 432.247245291s or 7.204120755min
ashishshrestha@ashishshrestha:~/Documents/Assignment$
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6.

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ashishshrestha@ashishshrestha:~/Documents/Assignment$
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File Edit View Search Terminal Help
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33789 ZZ88 $6$KB$b90c6jJpeth5ed5g0Sbx0M0UUp09rh.y5GuqCcSWTSHy/3J2B3i180l0/hMXMYoTFXDD9dSsrtTuQBRQ/nPu11
33795 MZ94 $6$KB$bMQXziNDcN.a/wede0CxxfgzX6EPIDj7gKhkrNgpt7dhMDhif7M.HUFLY/ud3a0fuF9yrf/q/PAN9m7McV8fPI0
33634 ZY33 $6$KB$bMHM4BwdsJeALAYzXgEvILYB7sefBytk.nshSDJv0mZhnEhDwdUkJaJ/Mw8czRuTT4yDwmnqYh8itFw4J.7wiP1
33790 ZZ89 $6$KB$cOzn7XrcDiW51/tCCxSVYBhN48h.UE/zillIsmfyvgbcEf0dS8n3ZfHnewKqInq1g9EG0uXyXYQjHjs.9idY.
33796 MZ95 $6$KB$bYZ390krD6ZwQToJaEPGoeYXAmnpZCrJv6F/78YFipv37B8ITp4PHWsn8saFuPzybq5h9EcGymVLF1Iz.hkpG/
33791 ZZ90 $6$KB$b.AmGv0H0do1dybMLGKQDxy39xmQzv06FhKb3z2Rp14JQH2zTREWCBidoVp.QkWEUrcRo7EhXN3ps0cJNLG1
33635 ZY34 $6$KB$b.Ed8nmXm02L3MsNstkJfj2UoP/8GQ/zNP074wErFvBctwk2EmvwQbP6ZtVLBhW0WAw6CxXavGG0dLMTB4m0
33792 ZZ91 $6$KB$b2u/y9a0V3DSk3r8LahqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T1kQwM09C12H6qppIoqoAt.
33797 MZ96 $6$KB$bdtKrxhMmUUUyVgcae7i0vRuJ6m3duZzMP4b32p4M3DfdFgnfh162auHcQbs2ASGLISYqxcUR2JiJLJUca0
33793 ZZ92 $6$KB$bEnFrdr7i7tX8ZCnlb/eK3Ch/AV.lxky30EPdtauyKd667Ur4rwtp1bY306YgC.MvU5pKuA5p7cqHPu09dC/
33636 ZY35 $6$KB$bPaKuuSLrFup6Um5kL2DEqw/vEeqDxL2726.VNiI80aGUQE6zLm9f026Pcm/rfZqAYdT1bQD91.UMm3kFZT1
33794 ZZ93 $6$KB$b0Fv/5kUds9kmGZeZC5a3jV0QqnT3dRRnkXqznyEBPXMKLtfpp00Jk61LK74M9s6D3jv0y.cbU5BCR76/
33798 MZ97 $6$KB$b8Du73lfK7wBS0D4iYSKd3Eg7TbD/0HU1W//zKnZzYj2vDp534.4H51GVjwxFu1
33637 ZY36 $6$KB$b5e766p2Nmov81kYK8/CwrvGRHLS0d7/5ro6vTsXfgeyjMzfpwDU1qgbU2mBzs6u9aTDTTdFy/GnbVCCj0
33795 ZZ94 $6$KB$bZafET5X7msPbHed1s7cRTU/2cPiBv6Kg0Pmtfp7pbea9JFdj0p0tRkh.7.zfcTCAUjuav20J8JzB5wBMrto
33799 MZ98 $6$KB$b45Tt017zURxaqIpfRobVrxkli.JG1tXa7uFL29gR7vj6lyfm33CR5jrtQzLzeo8q1pVKEth/1ACnd1E2vtCx7.
33796 ZZ95 $6$KB$bqmB840ZKwV3t2f2gJnYawmgulVbjksZq8RbPyf4IhKFR1fl2xqNM0X1kalRzzhve4jxdSpEuoRMFgoTbblrj0
33638 ZY37 $6$KB$b4uCQ3uksQb/Ffr4z05vWarvPlouqiyz0yBFBtWFNayG57c5MkWkPbYagn/qzsl0brfruuR90rM3/YFHx5WiP0
33797 ZZ96 $6$KB$bRZgulWyaGjokrg7z540mE5YKH0njLUB0fcD4j1mjw6m0/1.aq984tnjvjjcc0rtg/Mng46CFLzyad9f1
33800 MZ99 $6$KB$bz.Aq1ZkbjdJrX3YnvjqJo0XGpzHReXwFIQ9ccoLEZ1kCFnvMVDFjWR2nFpQkz1SdbPAAmZmUx0DzaS8Vfj1
33639 ZY38 $6$KB$b2L5SSDlWvIwkv7GaiKq4NEIULBdfz70xaKxa1Gw0xrFmzeN/BzlBrrISf0GfgZvxZP54FRC3wxBazcWYq81
33798 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tIhRbPT6tQjwauj37zhmlEJKxNpqfb1VBLVdGe5411e3NFcNx10cz6vp2jwKrLb0
33640 ZY39 $6$KB$b5EP3SR.15Adu50DlyfjeDco5RbcBw0MNK1mXcI0v5DqT8bPfsH70Tisrp0v8U1yFdT5Noh2qsNEZgpIWSpC0
33799 ZZ98 $6$KB$beve8v4J80Plznp9U0BMugDaR0W7vNup481vC.09qaCaVvW0RvukxmPuwP1Mf320SPjtFzd6zugs19129QNb./
33641 ZY40 $6$KB$bKjcQKT07cfolBng2hChjXwL52R04bJTabJQ.3icixvdvrxvX296U1Gr2mnQRrkcdpoaqiviv3X/1t0PYo0YQ410
33800 ZZ99 $6$KB$b.N.yjw98UBTw/k8IfBvb5rTozwkj1/IyUyLkkvNQEyglPHCzjmcN8dH7431TL2GvrXjaACBBHnoZx6ugcYkaSrf1
33800 solutions explored
Time elapsed was 430344344965ns or 430.344344965s or 7.172405749min
ashishshrestha@ashishshrestha:~/Documents/Assignment$
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7.

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Terminal 9:40 પ્રાર્થના  ashishshrestha@ashishshrestha:~/Documents/Assignment
File Edit View Search Terminal Help
33787 ZZ86 $6$KB$a1D/FRkcrM23MBiISi4rjm.DHY3nPi09nhz07459ZXM0RDGj4oW0pURZE6oNVWrI3gwRW/NHqaTJLiM.aq070
33645 MY44 $6$KB$re.Jk5so50lg7/yj3uVkJtihyJ0TXE05z40FgtojochzuM35lMnZIZ5.ns.1Ny1LI9CV6yy0gIx5u5ZpkZf.
33788 ZZ87 $6$KB$98RtAp7wZrIHHQAD62owLTx0iMb/BD2si55ojlyKCR8vB6PGkF3TXaMnZBP0/2uFpPhT9Ao5qtbUp7lqUjs3V1
33646 MY45 $6$KB$mFztA6aZyEUJDGXZWR0IzPUqbrlyZx7TFT/zw/PZN2vL2C.N5I8C2wCGBk.BwKXuRZlkHY9Xc5LdZVgnIJHU/
33789 ZZ88 $6$KB$u9ocbjJpetHtted5g0SbxM0UUp09rh.y5GugCcSwTSHy/3J2B3i80L/hMXMY0TFxd9dSsrtTuQBR0/nPu11
33647 MY46 $6$KB$PiYWSzh2teJG5Up8cNlpVmS7420pjaf0GwyIN1d93xnlyZ3Qw1IzRZ6.DZmsNmDzYR01CRRw0mBg/NUIK1
33790 ZZ89 $6$KB$Cozn7XrcDiw51/tCCxSVVbhn4N8h.UE/zilLismfyvgbcEf0dS8n3ZfHewkQIinq1g9EG0uXYXyQjhjs/9idY.
33648 MY47 $6$KB$2viC9Chlfst043Gq0XXKzw0p57Bw5T7Tp5p9aJqDGehKc9WNH3KUks8/Erk1RQEewBYGLCJp0qBEjkDzd.vR5
33791 ZZ90 $6$KB$b.AMgv0HD01dybMLGEK0DxyX39mX0zv0Gfhk3z2Rpt14JQH2zTREwCBidoVp.QkWEUrcRo7EHXN3ps0cJNLG1
33649 MY48 $6$KB$U4SME01arGwmrTH8A/nYErhEd7W/qPY7S9hdP08WghPlg2X7gferrAbe85BeG6l7WeY4N7rhW05bLKRQIsn20
33792 ZZ91 $6$KB$b2e2u/y9a0V3DSk3r8LahqrblbH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQwmQ9C12H6qpPi0qoAT.
33650 MY49 $6$KB$xVPrhgomia568yT8Cth18mkjFmu.Jcdl0Z1YAd01m9esbe62PaShyl61e4LwtkX3L20qxw14fwSDWE0aM9R/
33793 ZZ92 $6$KB$EnFrrd7i7tXZCnld/eK3hAV.lxky30EPdTauyKd667Ur4rwtp1b3YQ60Y5gC.MvU5pKuA5p7cqHPu09gC/
33651 MY50 $6$KB$b1FLAfhaov3dtsLzgNFke0v56IHkgQWoW2TRJghE4Zj9l0fuw30DF3sf.iYSW8FBULBx18g9DCwhvuwUThTs1
33794 ZZ93 $6$KB$b02Fv/5kUDsa9KmgZeZC5az3jVqvn7d3RRnkXqnzvEBPXMKLtfdfpk003JKB61LKw74M9sf6D3JvQy.cbU5BCR76/
33652 MY51 $6$KB$bZCpwvJca2jx8WPB0TSqL4AGRUT9d/855Y10qLNctsk670.FNl:EaK7utk9a543gBB97Ran5qCpv2qfaw000.
33795 ZZ94 $6$KB$bZaET5X77msPbHed1s7rTU/2cPIbv6KGoPmtfp7pbea9JFdjo0pTRHk.7.zfcTCAUJuav20J8JZb5wBMr0
33653 MY52 $6$KB$bvxGuJyQ5q4Zm1Cd311wDFmtu3BcycohmBtC0Y8V0rTb9WzAn2X/4gGHZxHsyw8K/8VOLNBQzIjdomb4EE/
33796 ZZ95 $6$KB$bqmB8402ZKwV3t2f9JnYamuglVBjksZq8RbPyf4IhKFR1f1L2xqNM0X1kalRzzhve4jxdSpPEuRMFgTBblzrj0
33654 MY53 $6$KB$btskeHfhIAV.xjxSnhmw11bhxfA.1oVowb90YbzDjgNYWJmlDYIpqK1x.wZ0jkwmwULDS0jt033x8Kxa5iYnt.
33797 ZZ96 $6$KB$bURZgUhWyaGjokrg7zK540mE5yYKHOnjLUBQfD4JjmJwW6m0A/1.aoc984tnjwvjCC0Rt6/MNg46CFZyad9f1
33798 ZZ97 $6$KB$bM16hksBWE0YCD/FxJN0tIhRbPT6tQwauj37zhmLEJkXNpfb1VbHLDge5411e3NFNCNx1l0cz6vp2jwKrlb0
33655 MY54 $6$KB$bFFU79QAgts1N8B2qnTxMEGU5Ctjd4FvJuiKhRqNwpQo9G/HlzUrFv0MvZzgEA1fje6phKgu5niInYr/Li/
33799 ZZ98 $6$KB$eve8v4J8QPLznp9uOBMugdaR0W7vnUpY48lvC.09qCaVvWorVuKxmPwP1Mf320SPjtFzd6zugsi9129QNb./
33656 MY55 $6$KB$da6mSlwQvEh2PHDzx53L3Tqjr.qKsGdIyElvBRe9ecu5J0NbEndD5yprXNqwrJKA660eL2vD03SCfgXb/cZTM/
33800 ZZ99 $6$KB$b.n.Yjw98UBTw/k8IfVb5v7TozwkjI/Uy1lkvNQEyg1PHCzjmcN8dH7431TL26vrXjaACBBHnoZxGugeYkaSrf1
33800 solutions explored
Time elapsed was 430508554030ns or 430.508554030s or 7.175142567min
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 
```

8.

```

Terminal 9:47 પ્રાર્થના  ashishshrestha@ashishshrestha:~/Documents/Assignment
File Edit View Search Terminal Help
33608 ZY07 $6$KB$H.HpAz9jmFRIZXY/CZRc8.gutvZEK/8DNVi6U7scrjV0AXQXq.o4jUzZnqx0.I.h8geiRB5ydEu9MgdgbUma.
33759 MZ58 $6$KB$ERgFrJrbM9hVoncIohu5279TaJEl.4hyHbp5KHnk0d8ZInGvUY.wGoyTUTUdfds8j6hk.EI10GKVtqUbv07g.
33794 MZ93 $6$KB$PeqPP61.qRm90d0dtFX5rd3B0jI/s3o58ij/nG4V74V5ZR4JQsvK1My6Sh7doJ2wkGgJo5xG6uhN7vBGHYHc./
33596 MX95 $6$KB$b1/74nj6PifdFLYlP0Gv5YERYV8XB6E.BAWGcwFmlJRYwqptyhGAASdN1F3ETvM0Itynyjq3xswwsWodpazvw.
33609 ZY08 $6$KB$bideu5760wF9Rultd9jALN1s542WRbzfjB9k6kIM74qzIxRhyPfgcq0aERnbir1vSrlYfk4Fybxx14.
33760 MZ59 $6$KB$bMKMLRqLdhWtv8Bdyj22PUpfleqmqddcQMF01z02wxuQinwueP67i5Vb3QUPFBpVse8MPWpI02WJwCsler0R6DW.
33795 MZ94 $6$KB$bMQxiNDCh.a/wede0CxXfgzX6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY/ud3a0fuF9yrf/q/PAN9m7McV8fPI0
33597 MX96 $6$KB$bRhsDjntAbTZeQ8/lvmQceAPL/04314kwTDUjKUv/02tVghXj.r.sQ89f9vT8T90dyhENqE.QRDUXoEi8z0uJ1
33610 ZY09 $6$KB$bHEYUx5ZFI0k1EqFd/HDDRPr0RmqNohty1ge4d08L1PcJUViaKCuVmKjlK5gzHipGI013s1v/wjw6Xiz5V0
33761 MZ60 $6$KB$bJHF/HanWfLnGv4NHI5zQEL.wnheIwQ5u9sL8u/c4cJUN0Treh5eyi.03giAefv0Pw6p86401rGqicfvxZd0
33796 MZ95 $6$KB$bY2390krD62wQToJaEPGeoyXAmnpCrjV6F/78YFipv37B8ITp4PHwsn8afUePzyb5h9EcGymVLFl1z.hkpg/
33598 MX97 $6$KB$/7HSG59dHgc7mzFkdLUkrksZM4kCgSeyjdIx10NKGdsTs2G7S0NwGFRMMXG.EzbzR.P1X0iu0TeCzB2vuLz.
33611 ZY10 $6$KB$bNj6bkTjhW3f5g9HeAaAtbdIXXjyC0McAlrD5f3cg84uWgFch7incFkCBliliwbtfsU.vPnqHGUba80
33762 MZ61 $6$KB$ovc5PvQBCDRFfsoa0y0nvjg.xCmp2cmkXhpybk1ANIIyM5Eiq60vR/7zChnqDBJbCYuPsOs18aAE0/CRqXw.
33599 MX98 $6$KB$briovt8x65w0Unywuvvcjlc190Wms4x7sBkKpsCwa0VAbh/BKWN7ByU0hj02Hw3.01s3X51JA89lZM43fVm/
33797 MZ96 $6$KB$dbtKrxhMmUJUyVgCae7iQvRuJ6mM3duZzMP4b32pP4M3DfdFgnfh162auHcQbs2ASGLISYqxcUR2JiJLJucA0
33612 ZY11 $6$KB$bJz4MLk6gp16o5BSd.Onjhln47VzTefCaGIUNUJxtBh8vWhwvhuEpQ3Lzf51ZUaw0WUBapgVpnmxjQNvgvlw1
33600 MX99 $6$KB$bN9R0o.V8j1EHX4aSpM0IP57xr/y.RvG7YS2Red.W1dl6ateQILjhMui.diujp56PD88Lv09tJ6zNAP/6B2U0
33613 MZ97 $6$KB$b2KcrHrDfUe32/00DqrJjg2J0fKy4d88LfyAvg78FvtLcnqT5taNdhbkE02zQqrjjtuFHzyso/4qhcr61L770
33798 MZ97 $6$KB$bH8du73lfk7wBS0D4iYsKd3EgT0R/Vo96ZPdY8iaEcuz3cf7TbD/0HU1W//zKnZyj2Vdp534.4H51GVjwxFu1
33763 MZ62 $6$KB$Enq/Lcls/nbKka9CqAy2v2XgedSm0m.v066arfIHvifsvWdnIeXrgamZ6Njg0p0VKClmb2jjNs0EmArf3vXEG.
33601 MY00 $6$KB$b1A73DwqjGxe91/A57zK1132l5gAgfN7LJ5eZTfsru1jYe0GhahN5ev0TLZv1Td.Q8hRvxqrojHtGtkuou/
33799 MZ98 $6$KB$b45Tt0j7zUxraqIpfRobVrxkli.JG1txa7uFL29gR7vj6Lfym33CR5jrtQzLzo8q1pVKEth/1ACnd1E2vtCx7.
33614 ZY13 $6$KB$b2HSPRT.YNEnK413w6j7/Vts1EicGRKh40Vmu4pfrwSKfawXp4jix.KZqKhkB20RyLsxE9ZS01fgTEL5vsuXtz/
33764 MZ63 $6$KB$bMsKFKA.S.QIdMcEBhb5bAXWB4I1Y70y306VfpVn/k9YMoZ94VJGhsAvYp0xW4w7l32NSzx4CiQkKZ004pUiw01
33602 MY01 $6$KB$/mCKhtuMzGr1jC2X5WX..4GKkft0jAGkaqXawDoswW92JKzv.tt6fVUKrJmlkdjz58pzu0BrkUmXHeqTY0A41
33800 MZ99 $6$KB$b.kz.Aq1ZkbJdJrX3Ynvqj0oXGpzHReXwFIQ9ccoleZ1KcxFnvMVDFjWR2nFpXQkz1SdbPAAmzUmux0DzaS8VfJ1
Time elapsed was 431871656769ns or 431.871656769s or 7.197860946min
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 
```

9.

```

Terminal
ashishshrestha@ashishshrestha:~/Documents/Assignment
File Edit View Search Terminal Help
33720 ZZ19 $6$KB$FD8k2rCF14n30eQ0hrlc6gqf91..jiydDt0/znVJ7Q7I0pebFhrNNMhyr75cw8eLm2d5Gkop.pjtziGkofRJ5/
33772 MZ71 $6$KB$/JrDim8Xr0/o312uD16PPrdTokE.ePSiWls8F0k7RycgAuf05Twnh01CC20.Qd4v.r.1qQ0MH09UT6N7a970i0
33789 ZZ88 $6$KB$u9oc6jJpetHtted5g0Sbx0M0UUp09rhn.y5GuqCcSWTSHy/3J2B3i80lq/hMXMyoTFxd9dSsrTuQBRQ/nPu11
33790 ZZ89 $6$KB$Cozn7XrcDIw51/tCCxSVYBhN4N8h.UE/zillIismfyvgbcEf0dS8n3ZfHnewKqInq1g9EG0uXyXYQjHjs/9idy.
33721 ZZ20 $6$KB$kvWj1TbCzHF9H75H9kt70eTtV.wXUepB.0K2YAYUjfna/HkUYujWj5G0kpLmMZ1C9Bzbetutbg.FP7iREcwm.
33773 MZ72 $6$KB$duwH0rN0s1BL21.xTj5wNbds3IygbTJPhc390G.CajcnBREldmAxzqnFuvagqcJ0pzYQ0J/lzUw0qWc3hLF1
33791 ZZ90 $6$KB$e.aMgv0HD01dybMLGEKQDxyX39mXQzv0GFhKb3z2RPt14JQH2zTREWCBIdoVp.QkWEUrcRo7EhXN3ps0cJNLG1
33722 ZZ21 $6$KB$/KGSDuiItsu.JyPmwgLnuK86x0F157RGKE1lqYo3pMwZX2vsx3k3YbdW51L0SjFes4x65NzQiyMyE7P4VCG1
33774 MZ73 $6$KB$pb6vka1Uc81/uGPA3Y14CG319gk6bw/Fd8uGI0eksAFKA75YTJet0qphbxP1bbtJFxsn2Mu6KtfjmlKovu0
33792 ZZ91 $6$KB$e2u/y9a0V3DSk3r8LahqRiblH6CpkhLYC9CwUgWe4.QqxMd5bbEvau9gahVvF6T19kQw09C12Hgqppi0qoAT.
33793 ZZ92 $6$KB$EnFrrd7i7tX8ZCnld/eKc3H/AV.lxky30EPdTauyKd667Ur4rWtp1bY306Y5gC.MvU5pkuA5p7cqHPu09qC/
33723 ZZ22 $6$KB$FflndVY4o.gHmUpulnQ.uGNQDcf8xtTnn6KghhYL1nltSoCwkt/P6n7nydLuwnfLSMMwYHtyw3Zy5g7R9Jv.
33775 MZ74 $6$KB$v0$0Gruvwjp5JU0yj0eXz42qyf4HDkshay4jNaQvc05DA0/S.t2EPSTSScuvcyEuwn6cjhvn0MJ83JUs0.Bthb0
33794 ZZ93 $6$KB$0zFv/5kUds9KmGeZC5az3jV0qnd3RRnkxQznvEBPXMKLtdffk00JK61kW749nsf6D3jv0y.cbU5BCR76/
33795 ZZ94 $6$KB$zaFET5X77msPbHed1hs7cRTU/2cP1bvr6KGoPMtpf7pbea9JFdj0p0tRHk.7.ZfcTCAUJua20J8Jzb5wBMrt0
33724 ZZ23 $6$KB$VLh2/NQRxTPcC9v6s1F2lC91fEvkHbzZNaEoAIkLp1.Cz72aZJ9Ynv0Iyrs.bVc7U6DAvlzfJ8CVYnuzwHv1
33776 MZ75 $6$KB$Dz8kP.U.08z14T2Hco.6DGx328kNQZ053YmhNbvH2ZRIlcrVp16m6kF7Z1q/BHKKU0GajZqp20w3h6hjg00
33796 ZZ95 $6$KB$qmB840ZKwV3t2fgJnYawmuglVbjksZq8Rpbyf4IhKFR1f1l2XqNM0X1kalRzzhev4jxdSpPEuoRMFgoTBblzrj0
33797 ZZ96 $6$KB$URZgUnWyaGjoKrg7z540mE5YVKhOnjLUB0fcD4j1jmJvw6m0A/1.aq984tnjvvjCC0rtG/Mng46CFLzyad9f1
33777 MZ76 $6$KB$jSh0ffzN0QH2SojHRA3.GBwyLfusTIVGipP8/yghbh9lRE2I81k8tCIqR9nVY210J1PfkLm2.cm2EnradEY.
33725 ZZ24 $6$KB$qGxZCeb8SvYDziI3XohlaDKLm1njHiEFWQ.v1qn8w5m385GBBbi7SPVYjmTH4q/M8zxjFx4nx83RKyar5jW/
33798 ZZ97 $6$KB$Mil6hksBWE0YCD/FxJN0tIhRbPT6tQjwauj37zhmLEJkXNpqfb1VBHLVdGe5411e3NFcNXi10cz6vp2jwKrLb0
33799 ZZ98 $6$KB$eve8V4J8QPlznp9U0BmugRa0W7VnUpY48lvC.09qaCaVwWoRVukxmPUwP1Mf320SPjtFzd6zugsi9129QNb./
33778 MZ77 $6$KB$scYGL394iX5/reMbZhDhsToV0bHzB1x8PjxpgYYtYx054cNPKqj4ziAe0HYelLiUpTsyPrnEb.29ERqlIhx.
33726 ZZ25 $6$KB$/dbav6L7zwoj5lewpH.B6imeut0RqmIMySHUVFV88QYH.isjfiLzICrewDQnUX/1/SI5FHqJQdJ7WieqTPS9K0
33800 ZZ99 $6$KB$n.Yjw98UBTw/k8Ifbv5+Tozwkj1/UyYlkvNQEyg1PHCzjmcN8dH7431TL2GvrxJaACBBHnoZx6ugcYkaSrf1
33800 solutions explored
Time elapsed was 433916258052ns or 433.916258052s or 7.231937634min
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 

```

10.

```

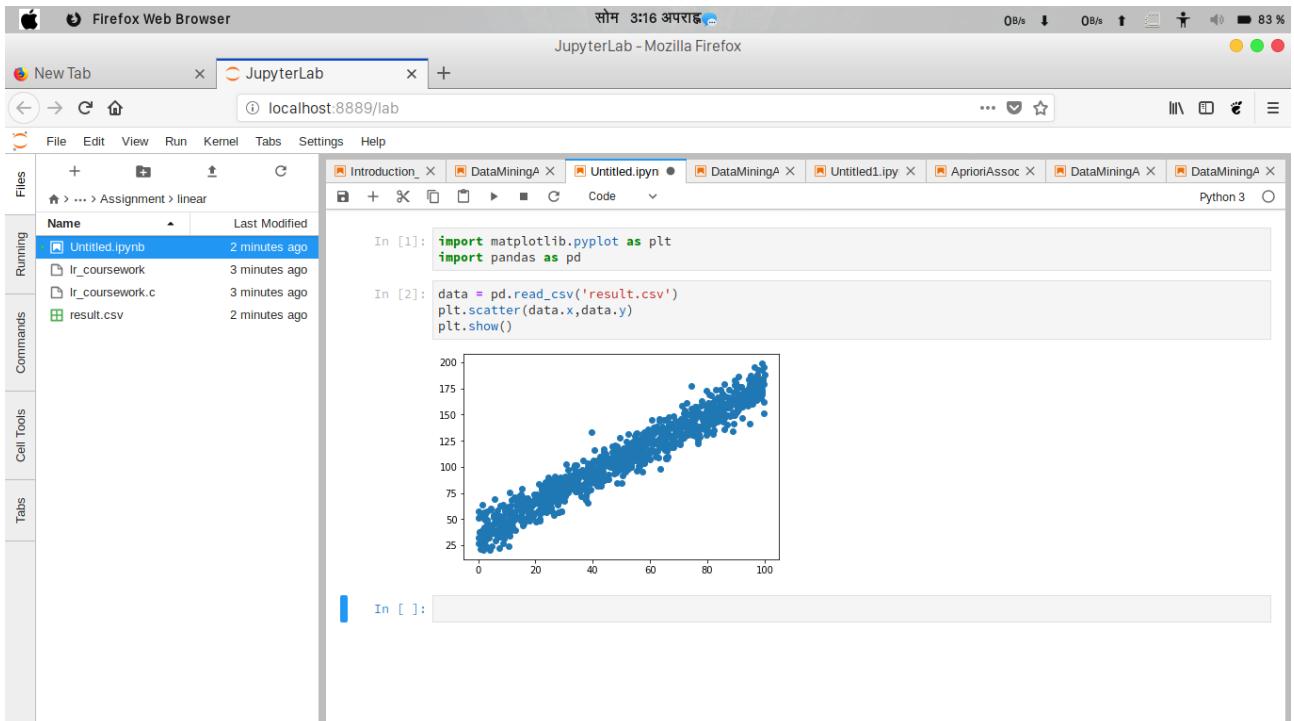
Terminal
ashishshrestha@ashishshrestha:~/Documents/Assignment
File Edit View Search Terminal Help
33787 ZZ86 $6$KB$a1D/FRkrM23MBiISi4rjm.DHY3nP109nhzZ07459ZXM0RDGj4oW0pURZE6oNWRi3gwRW/NHqaTJLjMu.aq070
33655 MZ54 $6$KB$wFFU790Agts1N8B2qnxTxMEGU5CtJd4FvJuiKhRqN0Wp0i9G/HLZlrfv0MvZzgEA1fje6phKu5niINyR/Li/
33329 MV28 $6$KB$XxleyD90NuFZ.2Sy/pr8ldYHgnty2dIeq0p51DcydX0E6rKsCZbcH6rBJ65SuFVh4fLn1J56XkE213XRrX1
33793 ZZ92 $6$KB$EnFrrd7i7tX8ZCnld/eKc3H/AV.lxky30EPdTauyKd667Ur4rWtp1bY306Y5gC.MvU5pkuA5p7cqHPu09qC/
33795 MZ94 $6$KB$MOXziNDCh.a/wede0CxXfgzX6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY/ud3a0fu9yrf/q/PAN9m7McV8fPI0
33788 ZZ87 $6$KB$98RtAp7wZrIHHQAD62owLTx01Mb/BD2s155ojlyKCR8vB6PGkF3TxMnZBPO/2uFpPhT9Ao5qtbu7lqUjS3V1
33330 MV29 $6$KB$UKat6Phi.GiotLwNHLXN/vwpY9eIxTnFDK26rZz1B7YariwttooJrrWmW6ioEbWOLuDb9TjgWF7u/w93kRrT.1
33792 MZ91 $6$KB$VcYtwN7vtfmo5N1CQJwdJIp6.FXUx0p9z9H2ifLC5x.q70K15HGSxe0Pw/V5E9KL2Hllx0pRK0KwYCXUHii1
33656 MY55 $6$KB$da6mSlwQveH2PHDZx53L3Tqj.r.qKsGdIyElvBRE9ecu5j0NbEndD5yprXNqwrJKA660eL2vD03ScfGxb/cZTM/
33796 MZ95 $6$KB$YZ390krD6ZwQToJaEPGoeYXAmnpZCrJv6F/78YFipv37B8ITp4PHWsn8safUePzyb5h9EcGymVLF1z.hkPG/
33793 MZ92 $6$KB$Mqh90mH9Yw55CKa0v5/Lr.rlM7.gASrxpWYQhMtUw250szh.HwiK1IqxbK1tvditriYRNr7bmbzQz1iel5Ei0
33789 ZZ88 $6$KB$u9oc6jJpetHtted5g0Sbx0M0UUp09rhn.y5GuqCcSWTSHy/3J2B3i80lq/hMXMyoTFxd9dSsrTuQBRQ/nPu11
33794 ZZ93 $6$KB$u9oc6jJpetHtted5g0Sbx0M0UUp09rhn.y5GuqCcSWTSHy/3J2B3i80lq/hMXMyoTFxd9dSsrTuQBRQ/nPu11
33797 MZ96 $6$KB$dbtKrxhMmJuUyVgCAe7iQvRuJ6m3duZzMP4b32pP4M3DfdFgnfhL62auHcQbs2ASGLISYqxcUR2JiJLJUca0
33331 MV30 $6$KB$eeYjdBclsrTqCd9ns0554.k5Jd0lVNiQgf31ne0BleVxb700LRh9prbkz0zINFj3lzbXgg8/zEytGkMB8B1
33794 MZ93 $6$KB$PeqPP61.qRm90d0tF5x5rd3B0jI/s3o58ij/nG4V74V5ZR4QjsvK1My6Sh7doJ2wkGgJo5xG6uhN7vBGHYhC./
33795 ZZ94 $6$KB$zaFET5X77msPbHed1hs7cRTU/2cP1bvr6KGoPMtpf7pbea9JFdj0p0tRHk.7.ZfcTCAUJua20J8Jzb5wBMrt0
33798 MZ97 $6$KB$h8dU73lfK7wsD04i3K3EgT0R/Vo96ZPdY8iaEcUz3cf7tbd/0HU1w//KnnZyj2Vdp534.4h51GvJwxFu1
33332 MV31 $6$KB$Z.QrnjNeqRLK7Ra33bADATPJeSu0p4BDw3ld8p1FelsvSk3xi2xBGUWxigA2u0zgmw/42cCUMDVUaZ6Hp.
33795 MZ94 $6$KB$MOXziNDCh.a/wede0CxXfgzX6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY/ud3a0fu9yrf/q/PAN9m7McV8fPI0
33657 MY56 $6$KB$xGBZgxU.jmkHI3v2Rpx7rYk4a/bjxAYsQtYd341BExs3w7s862qYKb1Isj43.oXcsD9nb7NnbM6qxdEy0
33799 MZ98 $6$KB$45Tt0J7ZuRxqAqIpfbRobVrxkLI.JG1tXa7uFL29gR7vj6Lyf3m3CR5jrtQzLze8q1pVKEth/1ACnd1E2vtC7x.
33333 MV32 $6$KB$js0fAD.synUymkMG65f4/I38e9Y9rkuk.Ybf9YdgCOCQcjuMUwgvsTuhc8XZ9Vih9wK2a/Y0cEAXBX2R/P9H.
33796 MZ95 $6$KB$YZ390krD6ZwQToJaEPGoeYXAmnpZCrJv6F/78YFipv37B8ITp4PHWsn8safUePzyb5h9EcGymVLF1z.hkPG/
33790 ZZ89 $6$KB$Cozn7XrcDIw51/tCCxSVYBhN4N8h.UE/zillIsmfyvgbcEfQdS8n3ZfHnewKqInq1g9EG0uXyXYQjHjs/9idy.
33797 MZ96 $6$KB$dbtKrxhMmJuUyVgCAe7iQvRuJ6m3duZzMP4b32pP4M3DfdFgnfhL62auHcQbs2ASGLISYqxcUR2JiJLJUca0
33800 MZ99 $6$KB$zk.Aq1ZkbDjJrX3Ynvqj0oXGpReXwFIQ9ccoLEZ1kCFnvMVDFjWR2nFpXQkz1SdbPAAmMux0DzaS8VfJ1
Time elapsed was 475311364531ns or 475.311364531s or 7.921856076min
ashishshrestha@ashishshrestha:~/Documents/Assignment$ 

```

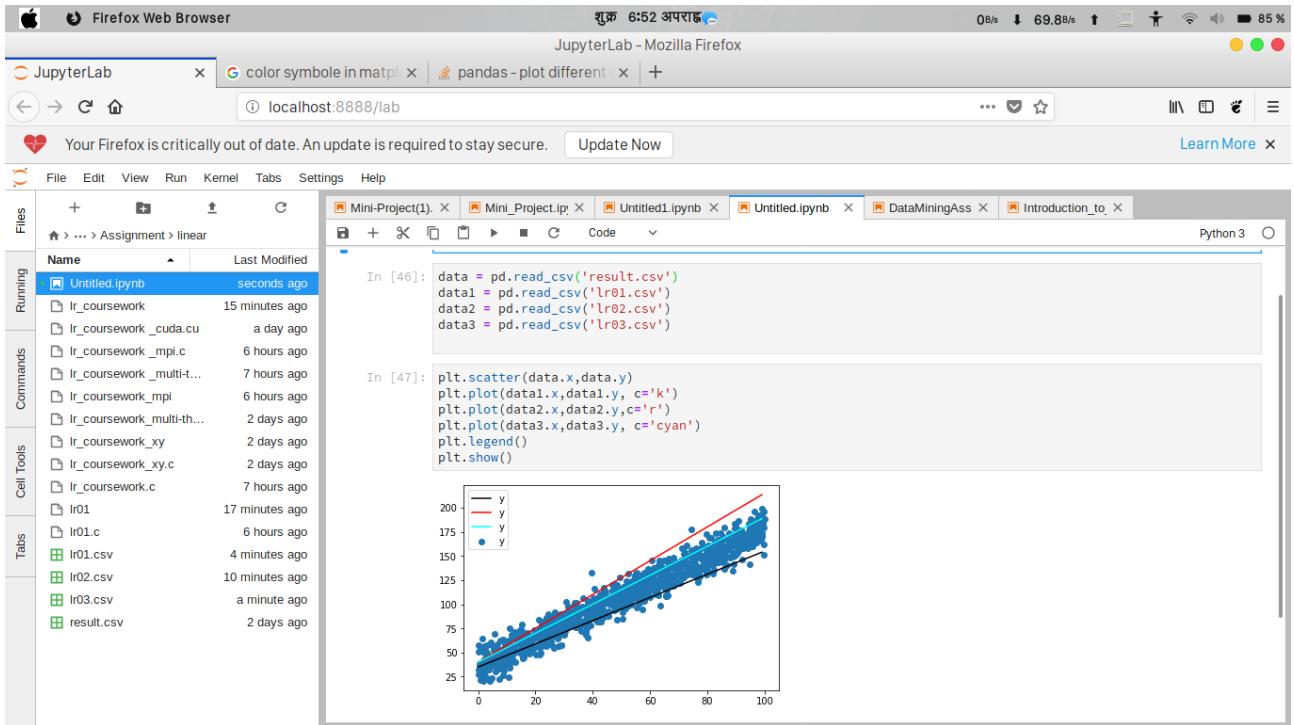
## Time taken by Image Processing multi-thread program.

```
Terminal शनि 1:36 अपराह्न
ashishshrestha@ashishshrestha:~/Documents/Assignment/014
File Edit View Search Terminal Help
image dimensions 100x72
Time elapsed was 276838ns or 0.000276838s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 386129ns or 0.000386129s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 563675ns or 0.000563675s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 390902ns or 0.000390902s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 624942ns or 0.000624942s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 587150ns or 0.000587150s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 371939ns or 0.000371939s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 629257ns or 0.000629257s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 600857ns or 0.000600857s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_multi_thread_014
image dimensions 100x72
Time elapsed was 544998ns or 0.000544998s
```

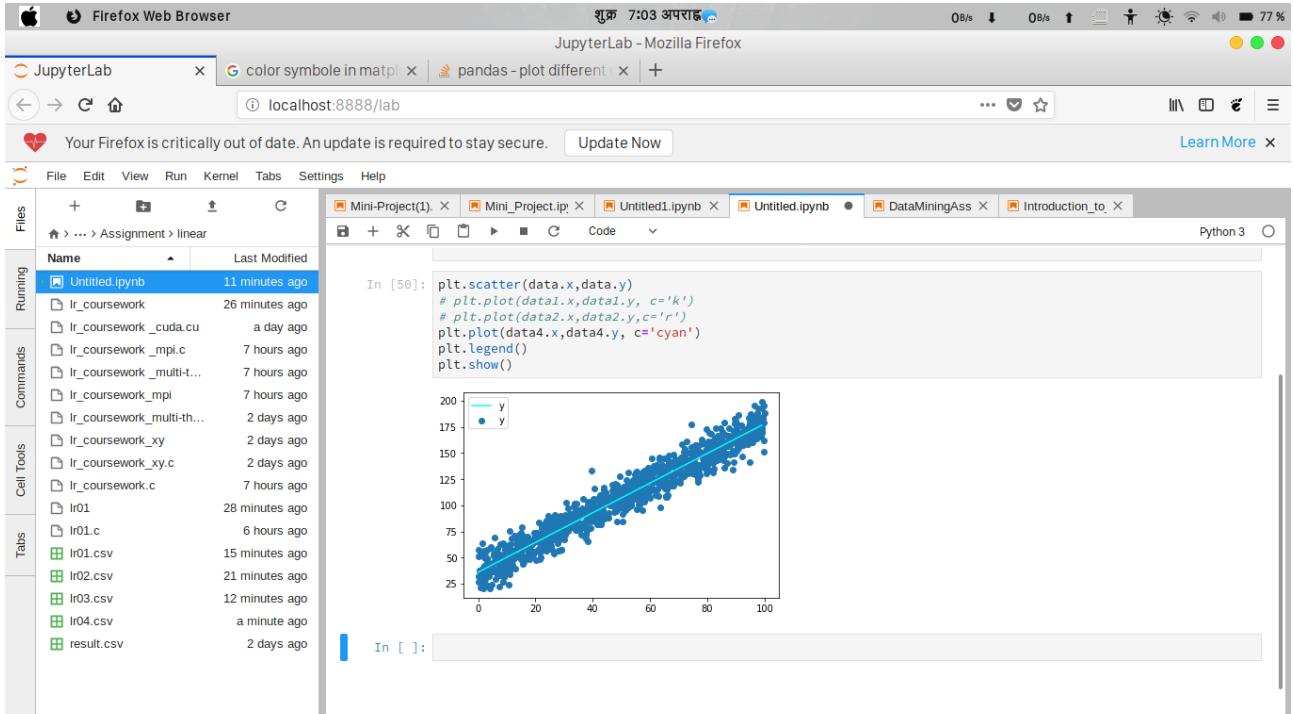
## Scatter Plot of data-set given.



Three guesses at the optimum values for m and c plot diagram.



Overlaying the line that was found by the program on to a data-set scatter plot diagram.



## Time taken by Linear Regression multi-thread program.

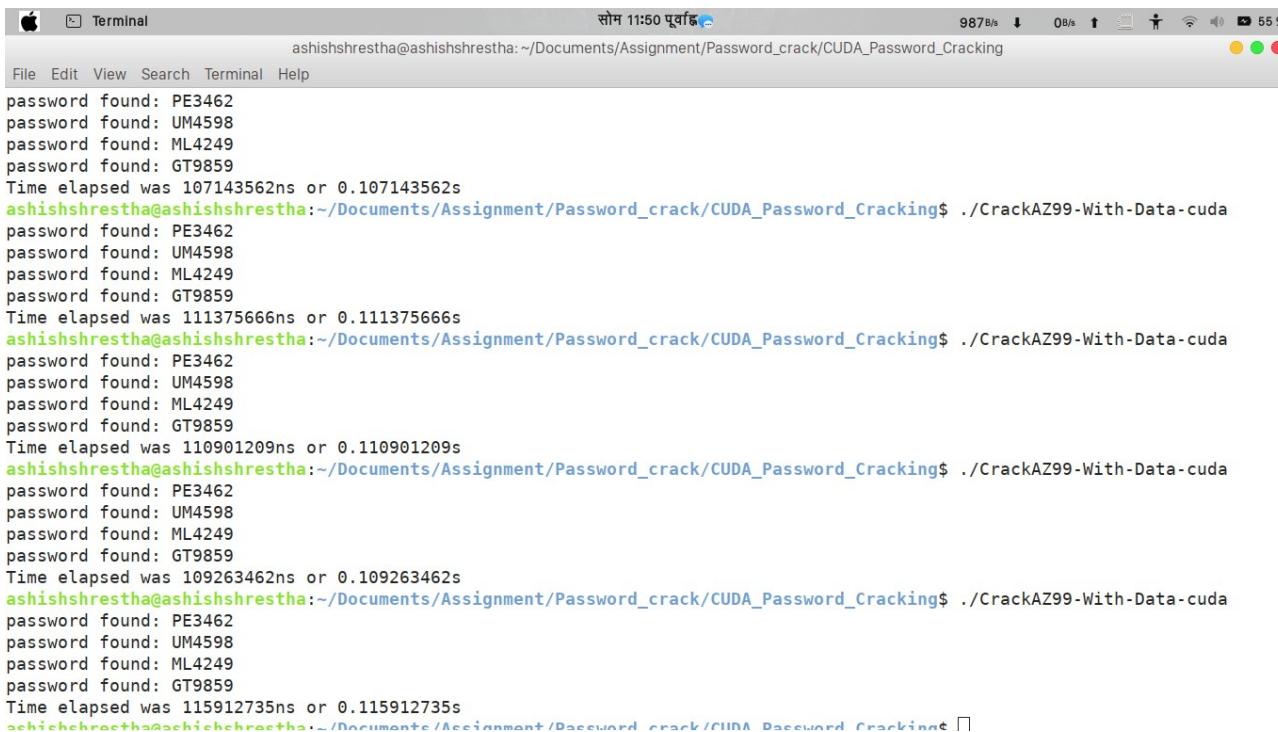
```
Terminal शनि 6:03 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/linear
File Edit View Search Terminal Help
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 729684644ns or 0.729684644s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 730370932ns or 0.730370932s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 729603310ns or 0.729603310s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 730406606ns or 0.730406606s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 720501911ns or 0.720501911s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 730797864ns or 0.730797864s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 731083206ns or 0.731083206s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 712123609ns or 0.712123609s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 744400154ns or 0.744400154s
ashishshrestha@ashishshrestha:~/Documents/Assignment/linear$ ./lr_coursework_multi-thread
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 707047138ns or 0.707047138s
```

## Time taken by 2-initials-4digits Password Cracking CUDA version program.

1.

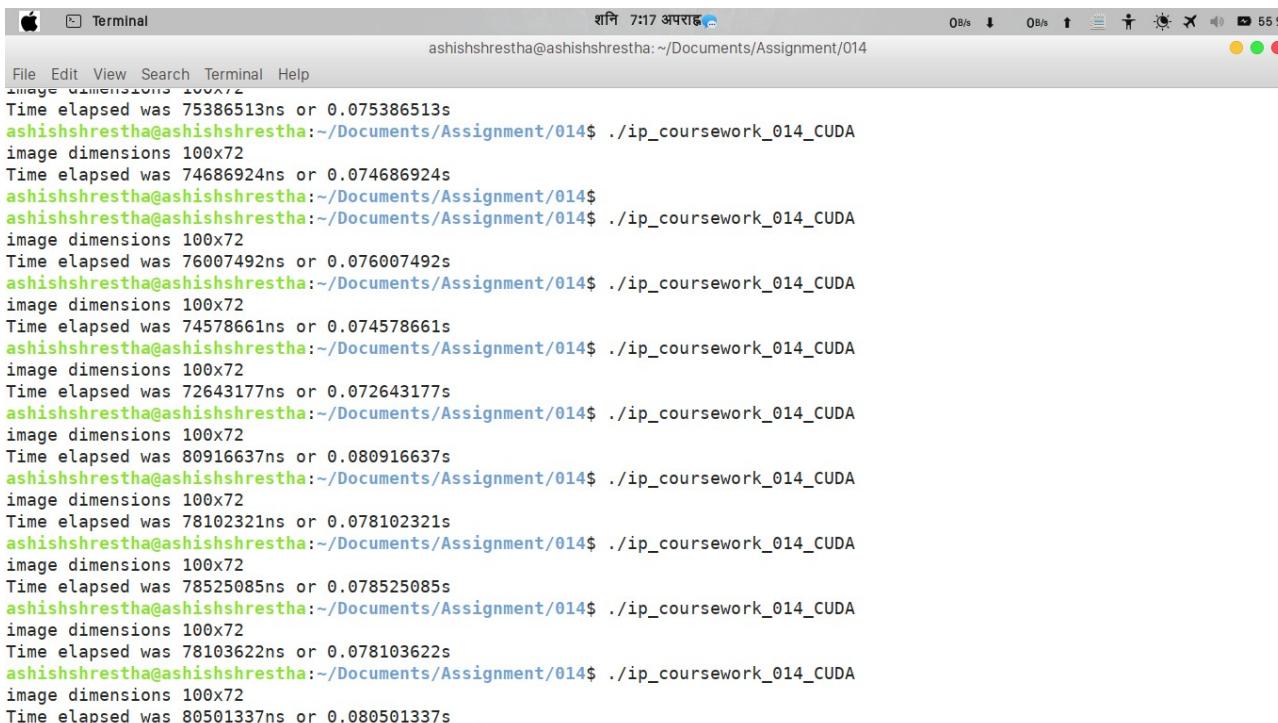
```
Terminal सोम 11:50 पूर्वाह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment>Password_crack/CUDA_Password_Cracking
File Edit View Search Terminal Help
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 109940907ns or 0.109940907s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 103769861ns or 0.103769861s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 103947175ns or 0.103947175s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 106515338ns or 0.106515338s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 111379871ns or 0.111379871s
```

2.



```
सोम 11:50 पूर्वाह्न
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ 987 B/s 0 B/s 55 %
File Edit View Search Terminal Help
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 107143562ns or 0.107143562s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 111375666ns or 0.111375666s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 110901209ns or 0.110901209s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 109263462ns or 0.109263462s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$ ./CrackAZ99-With-Data-cuda
password found: PE3462
password found: UM4598
password found: ML4249
password found: GT9859
Time elapsed was 115912735ns or 0.115912735s
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/CUDA_Password_Cracking$
```

Time taken by Image Processing CUDA version program.



```
शनि 7:17 अपराह्न
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ 0 B/s 0 B/s 55 %
File Edit View Search Terminal Help
image dimensions 100x72
Time elapsed was 75386513ns or 0.075386513s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 74686924ns or 0.074686924s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 76007492ns or 0.076007492s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 74578661ns or 0.074578661s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 72643177ns or 0.072643177s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 80916637ns or 0.080916637s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 78102321ns or 0.078102321s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 78525085ns or 0.078525085s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 78103622ns or 0.078103622s
ashishshrestha@ashishshrestha:~/Documents/Assignment/014$ ./ip_coursework_014_CUDA
image dimensions 100x72
Time elapsed was 80501337ns or 0.080501337s
```

## Time taken by Linear Regression CUDA version program.

```

Terminal  शनि 2:26 अपराह्न ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 835166268ns or 0.835166268s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 835166268ns or 0.835166268s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 850222368ns or 0.850222368s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 842416066ns or 0.842416066s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 846832551ns or 0.846832551s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 841985201ns or 0.841985201s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 832571804ns or 0.832571804s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 841029730ns or 0.841029730s
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-CUDA$ ./lr_coursework_cuda
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 839885917ns or 0.839885917s

```

## Time taken by Password Cracking MPI version program.

1.

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Terminal शुक्र 8:40 अपराह्न ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/Mpi_Password_Cracking$ 
File Edit View Search Terminal Help
Instance 1 33777 MZ76 $6$KB$jShOffzN0QH2SojHhRA3.GBwyLfusTIVGjiPP8/yghbh9lRE2I8lKtCIqR9nVY2i0J1PfkLm2.cm2EnradEY.
Instance 1 33778 MZ77 $6$KB$bScYL394iXS/reMbZhDhHsToV0bHzB1x8PjxpqYYtYQ54cgNPkqi4ziAe0HYeLiUpTSyPrnEb.29ERqlIhJx.
Instance 1 33779 MZ78 $6$KB$b3kDvlwx7Z0XhfHAgyNxcc8wMEqjgjS5TIp2aVXPVvh014EvCuxvUJAm3Cw9.f3rkS03oY6zJ0mTYIbwjMdCs1
Instance 1 33780 MZ79 $6$KB$VHi9yizG4zL7b9E8141I5I4zYA1glNRPQVqAY2jT4V4cQcu1II1mHd14f00zKiR00Eg5686UAOFQd30lRPThy.
Instance 1 33781 MZ80 $6$KB$b03nj2X0Pth4RTAFJCdxlhrzvXMdleE9y682xg9Q1K8W9mc8jpmDs/s11J8xuE3xtbGjtezhDFMblLltDvptB1
Instance 1 33782 MZ81 $6$KB$BdqSFjsgsPCe6wnCyglHmxLxGqHNRV91t2KvDeF09sQBSn0FqTr/0HkJ82sK/dTSAqdZ/50.p89nxz5qdQT.
Instance 1 33783 MZ82 $6$KB$bftSEYQySde/IQ5JlxB4saXn7WLhsdbcGz6uEghGabb/hAFGK/UqsWkIN4q2waRGW6l8j/iPAqKKCXku1
Instance 1 33784 MZ83 $6$KB$bQvarl5dJG.KKhS1cA51ciHWPauHwUPOnzh.7vSJk7s77PCG.561Lfm5dFNv34HGq1ligteYxeGVqliZqw1.
Instance 1 33785 MZ84 $6$KB$xx7B2UU1LDbLLr0/VkISGC5E4deqh52dg3BRIFCsg/ZtQCpcFE0EsH1H1dNj3b6i8k5f8AR.czDATZjIapn0Q1
Instance 1 33786 MZ85 $6$KB$bV.v2kQ60N84N0cwKhlFH9yynYFze600DJ9bmabYuf3BrP1Ra2B2TnCAKuYPcgSnX2iwGpV0eQg9e6lYg/ky1
Instance 1 33787 MZ86 $6$KB$bmeCi3GrQiuHx19I808lxBlWPxEZ9HsRMvD2Hzu7IB3gBHCxZdj5wHATirVnwj.1Ks/e/5N0lFH8juKKy7Pgb9.
Instance 1 33788 MZ87 $6$KB$bie9jxPZYvfm0UXFeHd5zJymjZjps080kaxd.n0Cjb.v0n2St.uEd.4Cc9g0hTmEZff/FON0xaIsVwU6.s.n./
Instance 1 33789 MZ88 $6$KB$bXzBoeINIkfUxt7YMvH15beMuD8MPe2Yrl5JJs9dh8zkkPP0tPZHN5Bhm.5d5nDN6VF39XuRDKZNm0EtUp01
Instance 1 33790 MZ89 $6$KB$qe2317Y5uf04/QBWVffEdnTgLgi0tbAQE70s0raxR1/NR3Vfjr4Z/sMYA1Pj6ztPAE82fenkB0re.0k6Eo/
Instance 1 33791 MZ90 $6$KB$b.3U7tmQR42wNnjdpQcw8kcGSXRZaenksWAbvKHHNQdxAIEx2f5hab6bjnRUXqvvt9M1iyL20sP/2GTP4FP.
Instance 1 33792 MZ91 $6$KB$bVcyTwnJtvPftmQ5Nlc0JwdJIp6.FXUxQp0z9H2ifLC5s.q7OK15HGSxePoW/V5E9KL2H1lx0pRKQkWYCXUHI1
Instance 1 33793 MZ92 $6$KB$bMqh90mH9Yww5SCkA0v5/Lr.rLM7.gASrxpWYQhMtUW250szh.HwiK1IqxbK1tvditriYRNR7bmbzQz1iel5E10
Instance 1 33794 MZ93 $6$KB$bPeqGP61.qRm90d0dtFX5rd3B0j/s3058ij/nG4V74V5Z4RJQsV1My6Sh7do12wkGgJ05xG6uhN7vBGHYhc./
Instance 1 33795 MZ94 $6$KB$bMQxfiNDCh.a/wede0CXxfgX6EPIDj7gKhkrNgpt7dMDHif7M.HUFLY/ud3a0fuF9yrf/q/PAN97McV8fpI0
Instance 1 33796 MZ95 $6$KB$bYZ39okrD6ZwQTojaEPGoeYXAmnPZCrJv6F/78YFipv37B8ITp4PHWsn8safUePzybg5h9EcGymVLf1Iz.hkpG/
Instance 1 33797 MZ96 $6$KB$bdbtkrxhMmuJUuYvgCae7iQvRuJ6mM3duZzMP4b32pP4M3DfdFgnfh162auHc0bs2ASGLISYqxUR2jJLJucA0
Instance 1 33798 MZ97 $6$KB$b8Du73lfK7wBs0D4iYSkd3EgT0R/Vo96ZPdY8iaEcZU3zcfT7bD/0HU1W//zKnZzYj2VdP534.4H51GVjwxFu1
Instance 1 33799 MZ98 $6$KB$b45Tt0J7zuRxqIpfRobRxkLI.JG1tx7uFL29gR7vj6Lfyim33CR5j/rTQzLoe8q1pVkEth/1Acnd1E2vtCx7.
Instance 1 33800 MZ99 $6$KB$bKz.Aq1ZkbJdrX3Ynvqjo0XGpzHReXwFIQ9ccoLEZ1kCXFnvMVDFjWR2nFpxQkzt1SdbPAAMzmux0DzaS8VfJ1
33800 solutions explored
Elapsed Time: 448.548901729s or 7.475815029min
Elapsed Time: 448.544153572s or 7.475735893min
Elapsed Time: 448.548271750s or 7.475804529min
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/Mpi_Password_Cracking$ 
```

2.

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Terminal
ashishshrestha@ashishshrestha: ~/Documents/Assignment>Password_crack/Mpi_Password_Cracking
File Edit View Search Terminal Help
Instance 2 33777 ZZ76 $6$KB$/oI/6/zBFE5d0ZWnQjX8KqfhiycZeS3rttMpVNciVowhs0bdv2uZgBxZekV4xsDmQX6j6RGYs7mYf1WN/dllS.
Instance 2 33778 ZZ77 $6$KB$bRQ1EfP5K1Voc6KXNx55ikf70TwVmIPZESPztrNGHBNaf9UwGtuOqnw.4CXCEgW6NsneBm8YYwPbri5wpqlJL.
Instance 2 33779 ZZ78 $6$KB$bTgT36YAt8xlpqMgdceBUAngLdYg/hMifqg1XT2CH722XLM2fxJ1ccnXYn.gnGnksYvVPqsQtKqNgBkqjWger0
Instance 2 33780 ZZ79 $6$KB$bjs0ufb6Vgy.uFyEY.r5xEBoeAJw0hUXcj7htVsLM6ahexvt3aj4VYdh4nZ3wGrSztLFAMZlhbj7Ec6Ja9RW0
Instance 2 33781 ZZ80 $6$KB$bNA46P2pAMhjb233D8Q1kJupJepIgls1ePwZdGceYlwuzNptvnCJ8m6nWDAbHD0IDiLAJYWaKupt7IwTb12.
Instance 2 33782 ZZ81 $6$KB$b93pWA16kS0zyleETokjko69uFOEB297P.yD4s0YYV3oss54B2fLiwiJokjm9g451p.CXFQ0LDFcTdnON0d71
Instance 2 33783 ZZ82 $6$KB$b6CMCMoUrKSt0ALMmYBG3HnFOHqYnIUsEzNg6YbI84Nv4CpUXBynVzv9XdbKt08d07TmhFGSKSVw09ZNZMR// 
Instance 2 33784 ZZ83 $6$KB$b5yvseEGCALa25V01ntCeKs.CvADKQKpCUg.D./DV0UOPCPJsm1/1nBmsZNF211G4p5BeRawtC76jX07jGB1Z.
Instance 2 33785 ZZ84 $6$KB$b55xu.uaA902HKKVFT4DuCyc19eKkTEXCa/ZlkDca8KmDQ/Luu4kfsK8A8pqjt4wDKH2M3ft15X.00ysHPI90
Instance 2 33786 ZZ85 $6$KB$b1Pqgw4F2.75K.QfcsDeBwK0ieRK6DGKAVQyEw56.Duj96PdssQG20x474/VPYF4W7aoYGem8QxIWKMkco.0
Instance 2 33787 ZZ86 $6$KB$b1D/FRKcrM23MB1Isi4rjm.DHY3nP109nhYz07459ZXM0RDGj4oW0pURZE6oNVWR13gwRW/NHqaTJLiM.aq070
Instance 2 33788 ZZ87 $6$KB$b98RtAp7wzrIHQQAD62owlTxoiMb/B2si55ojlyKCR8vB6PGkF3TxAxnzbpo/2uFpPhT9AoSqtBUp7lqUjs3V1
Instance 2 33789 ZZ88 $6$KB$b9u9oc6jpetHtted5g0sbx0M0Uu0p0rhny.5GuqCcSWTSHy/3J2B3i80l0/hMXMYoTFXDD9dSsrtTuQBRQ/nPu11
Instance 2 33790 ZZ89 $6$KB$b0Czn7xrcDiw51/tCcXSVBhN4N8h.UE.zillIsmfyvgbcfQds8n3zfHhewKqInqlg9EG0uXyXYQjhjs/9idY.
Instance 2 33791 ZZ90 $6$KB$b.e.amgv0H0do1dybMLGEKQDxyX39mXQzv0GfhKb3z2Rpt14J0H2zTREwCBIdoVp.QkWEurcRo7EHXN3ps0cJNLG1
Instance 2 33792 ZZ91 $6$KB$b2u/y9a0V3DSk3r8LAhqRibl6CpkhLYC9CwUgWe4.QqxmD5bbEvau9gahVvF6Ti9kQWmQ9C12HGqppIoqoAT.
Instance 2 33793 ZZ92 $6$KB$bEnFr7d7t8ZCnld/ekc3H/AV.lxky30EPdTauyKd667t4r4wMtp1by13060Y5Gc.MvU5pkua5p7cqHPu09q/c
Instance 2 33794 ZZ93 $6$KB$b0zFv/5kUds9Km6zeZC5az3jv0qnTd3RRnkXqnvzEBPXMKTdfffkpo0JKB61kw74M9sf6D3JvQy.cbU5BCR76/
Instance 2 33795 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cPiBvr6K6GoPMtpf7pbeaqJFdj0p0tRHk.7.ZfcTCAUJuav20J8Jzb5wBMr0
Instance 2 33796 ZZ95 $6$KB$bqmB840ZKwv3t2fgJnYawmuglVBjksZq8RbPyf4IhKfr1fl2XqNM0X1kalRzzhve4jxdSpPEuoRMFgoTBblzrJ0
Instance 2 33797 ZZ96 $6$KB$bUrzgUnVyaGjokrg7zk540mE5yYKH0njLUBQfcD4Jjmw6m0A/1.aq984tnjvwjCC0Rt6/MNg46CFLZyad9f1
Instance 2 33798 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tihRbPT6t0jwau37zhmLEJKXNpqfb1VBHLVdGe5411e3NFCNx10cz6vp2jwKrLb0
Instance 2 33799 ZZ98 $6$KB$beve8v4J8QPlznp9U0BmugDaR0W7VnUpY48lvc.09qaCaVWw0RVukxmUwP1Mf320SPjtFzd6zugsi9129QNb./
Instance 2 33800 ZZ99 $6$KB$b5n.Yjw98UBTw/k8IfVbv5rTozwkjI/UylKkvNOEyg1PHCzjmcN8dH7431TL2GVrXjaACBBHno2x6ugcYkaSrf1
33800 solutions explored
Elapsed Time: 450.610815684s or 7.510180261min
Elapsed Time: 450.611970440s or 7.510199507min
Elapsed Time: 450.614477814s or 7.510241297min
ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 

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3.

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Terminal
ashishshrestha@ashishshrestha: ~/Documents/Assignment>Password_crack/Mpi_Password_Cracking
File Edit View Search Terminal Help
Instance 2 33777 ZZ76 $6$KB$/oI/6/zBFE5d0ZWnQjX8KqfhiycZeS3rttMpVNciVowhs0bdv2uZgBxZekV4xsDmQX6j6RGYs7mYf1WN/dllS.
Instance 2 33778 ZZ77 $6$KB$bRQ1EfP5K1Voc6KXNx55ikf70TwVmIPZESPztrNGHBNaf9UwGtuOqnw.4CXCEgW6NsneBm8YYwPbri5wpqlJL.
Instance 2 33779 ZZ78 $6$KB$bTgT36YAt8xlpqMgdceBUAngLdYg/hMifqg1XT2CH722XLM2fxJ1ccnXYn.gnGnksYvVPqsQtKqNgBkqjWger0
Instance 2 33780 ZZ79 $6$KB$bjs0ufb6Vgy.uFyEY.r5xEBoeAJw0hUXcj7htVsLM6ahexvt3aj4VYdh4nZ3wGrSztLFAMZlhbj7Ec6Ja9RW0
Instance 2 33781 ZZ80 $6$KB$bNA46P2pAMhjb233D8Q1kJupJepIgls1ePwZdGceYlwuzNptvnCJ8m6nWDAbHD0IDiLAJYWaKupt7IwTb12.
Instance 2 33782 ZZ81 $6$KB$b93pWA16kS0zyleETokjko69uFOEB297P.yD4s0YYV3oss54B2fLiwiJokjm9g451p.CXFQ0LDFcTdnON0d71
Instance 2 33783 ZZ82 $6$KB$b6CMCMoUrKSt0ALMmYBG3HnFOHqYnIUsEzNg6YbI84Nv4CpUXBynVzv9XdbKt08d07TmhFGSKSVw09ZNZMR// 
Instance 2 33784 ZZ83 $6$KB$b5yvseEGCALa25V01ntCeKs.CvADKQKpCUg.D./DV0UOPCPJsm1/1nBmsZNF211G4p5BeRawtC76jX07jGB1Z.
Instance 2 33785 ZZ84 $6$KB$b55xu.uaA902HKKVFT4DuCyc19eKkTEXCa/ZlkDca8KmDQ/Luu4kfsK8A8pqjt4wDKH2M3ft15X.00ysHPI90
Instance 2 33786 ZZ85 $6$KB$b1Pqgw4F2.75K.QfcsDeBwK0ieRK6DGKAVQyEw56.Duj96PdssQG20x474/VPYF4W7aoYGem8QxIWKMkco.0
Instance 2 33787 ZZ86 $6$KB$b1D/FRKcrM23MB1Isi4rjm.DHY3nP109nhYz07459ZXM0RDGj4oW0pURZE6oNVWR13gwRW/NHqaTJLiM.aq070
Instance 2 33788 ZZ87 $6$KB$b98RtAp7wzrIHQQAD62owlTxoiMb/B2si55ojlyKCR8vB6PGkF3TxAxnzbpo/2uFpPhT9AoSqtBUp7lqUjs3V1
Instance 2 33789 ZZ88 $6$KB$b9u9oc6jpetHtted5g0sbx0M0Uu0p0rhny.5GuqCcSWTSHy/3J2B3i80l0/hMXMYoTFXDD9dSsrtTuQBRQ/nPu11
Instance 2 33790 ZZ89 $6$KB$b0Czn7xrcDiw51/tCcXSVBhN4N8h.UE.zillIsmfyvgbcfQds8n3zfHhewKqInqlg9EG0uXyXYQjhjs/9idY.
Instance 2 33791 ZZ90 $6$KB$b.e.amgv0H0do1dybMLGEKQDxyX39mXQzv0GfhKb3z2Rpt14J0H2zTREwCBIdoVp.QkWEurcRo7EHXN3ps0cJNLG1
Instance 2 33792 ZZ91 $6$KB$b2u/y9a0V3DSk3r8LAhqRibl6CpkhLYC9CwUgWe4.QqxmD5bbEvau9gahVvF6Ti9kQWmQ9C12HGqppIoqoAT.
Instance 2 33793 ZZ92 $6$KB$bEnFr7d7t8ZCnld/ekc3H/AV.lxky30EPdTauyKd667t4r4wMtp1by13060Y5Gc.MvU5pkua5p7cqHPu09q/c
Instance 2 33794 ZZ93 $6$KB$b0zFv/5kUds9Km6zeZC5az3jv0qnTd3RRnkXqnvzEBPXMKTdfffkpo0JKB61kw74M9sf6D3JvQy.cbU5BCR76/
Instance 2 33795 ZZ94 $6$KB$bZafET5X77msPbHed1hs7cRTU/2cPiBvr6K6GoPMtpf7pbeaqJFdj0p0tRHk.7.ZfcTCAUJuav20J8Jzb5wBMr0
Instance 2 33796 ZZ95 $6$KB$bqmB840ZKwv3t2fgJnYawmuglVBjksZq8RbPyf4IhKfr1fl2XqNM0X1kalRzzhve4jxdSpPEuoRMFgoTBblzrJ0
Instance 2 33797 ZZ96 $6$KB$bUrzgUnVyaGjokrg7zk540mE5yYKH0njLUBQfcD4Jjmw6m0A/1.aq984tnjvwjCC0Rt6/MNg46CFLZyad9f1
Instance 2 33798 ZZ97 $6$KB$bMil6hksBWE0YCD/FxJN0tihRbPT6t0jwau37zhmLEJKXNpqfb1VBHLVdGe5411e3NFCNx10cz6vp2jwKrLb0
Instance 2 33799 ZZ98 $6$KB$beve8v4J8QPlznp9U0BmugDaR0W7VnUpY48lvc.09qaCaVWw0RVukxmUwP1Mf320SPjtFzd6zugsi9129QNb./
Instance 2 33800 ZZ99 $6$KB$b5n.Yjw98UBTw/k8IfVbv5rTozwkjI/UylKkvNOEyg1PHCzjmcN8dH7431TL2GVrXjaACBBHno2x6ugcYkaSrf1
33800 solutions explored
Elapsed Time: 457.101931998s or 7.618365533min
Elapsed Time: 457.099079393s or 7.618317990min
Elapsed Time: 457.100681187s or 7.618344686min
ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 

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4.

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Terminal
ashishshrestha@ashishshrestha: ~/Documents/Assignment>Password_crack/Mpi_Password_Cracking
File Edit View Search Terminal Help
Instance 1 33777 MZ76 $KB$jShOffzN0QH2SojHhRA3.GBwyLfusTIVGiPP8/yghbh9lRE2I8lK8tCIqR9nVY2i0J1PfkLm2m.cm2EnradEY.
Instance 1 33778 MZ77 $KB$scsYGL394iXS/reMbZhDhHsToV0bHzB1x8PjxpqYYtYx054cgNPkq14ziAe0HYLeiUpTSyPrnEb.29ERqlIhJx.
Instance 1 33779 MZ78 $KB$3kDvlwx7Z0XhfHAgyNxcC8WmEgjjs5TiP2aVXPYvh014EvCEUxvUJAm3Cw9.f3rkS03oY6zJ0mTYIbwjMdCs1
Instance 1 33780 MZ79 $KB$VH19yiy1zG4zL7b9e8141II14zYA1glNRPQvAY2jT4V4cQcu1II1mHd14f00zkiR00Eg5686UAOFqd30lRPTHy.
Instance 1 33781 MZ80 $KB$o3nj2XQPth4RTAFJCdxlhrzVXMdleE9y682xg3Q1KRW9mc8jpmds/sl1J8xuE3xtbGjteZhDFMblLltDvyptB1
Instance 1 33782 MZ81 $KB$BdqSFjsgsPCe6wnCyg1LmhLxxGqHNRV9y1t2KvDreF09sQBSnOfqTR/0Hk382sK/dtSAqdz/50.p89nxz50dQT.
Instance 1 33783 MZ82 $KB$hfTsEYQySde/IQ5JlxB4saXNn7WLihsdcbGz6uEGhhGgabd/hAFGK/UqsWkIN4q2waRGGw6l8j/iPAqKKCXku1
Instance 1 33784 MZ83 $KB$rVarl5dJG.KKhS1cA51ciHwpAuahAwUP0nzh.7vSJk7s77PCG.5611fMs5dFnV34Hgq1igteYxeGvqliizqwl1.
Instance 1 33785 MZ84 $KB$xx7B2UUJLDbLLrQ/vkISGC5E4deqh52dg3BRIFCsg/ZtQCqpcFOEsH1H1dNj3b6i8k5f8AR.czDATZjIapn0Q1
Instance 1 33786 MZ85 $KB$v.2vkQ60N84N0cwkhlfH9yyNFze600D9bmalYuf3B8rP1Ra2B2TnCAKuYPCgSnX2iwGpV0eq9e6lyg/kyl
Instance 1 33787 MZ86 $KB$meCi3GrQiuHx19I808lxBLWPxEZ9RsRMvD2Hzu7IB3gbHCxzDj5wHATirVnwj.1Ks/e/5N0lFH8juKKy7pgb9.
Instance 1 33788 MZ87 $KB$ie9jxPZYvfmOUxfEhd5zJymjZjps080kaxD.n0Cjb.vQn2ST.uEed.4Ccb9g0hTmEZzF/FON0xaIsVwU6.sN./
Instance 1 33789 MZ88 $KB$8X8zBoeINIkfU7YyMh5beMu8MPe2Yrl5JJus9hd8zkkPP0tPZHNS5bh.5d5nDN6VF39XuRDkZNMOEtUp01
Instance 1 33790 MZ89 $KB$qe2317y5UfQcU4M/0BwvfEdnTgLGijotbAE70s0raxR1/NR3Vfj4Z/sMYA1Pj6ztPAE82fenkB0re.oK6Eo/
Instance 1 33791 MZ90 $KB$3.3U7tmqRN42wNnJdpQcW8kCGSXZaenksWAkBHHNODxAIEx2f5hab6bjnRUXqvutd9M1iyL20sP/2GTP4FP.
Instance 1 33792 MZ91 $KB$VcYtnJtvPftmQ5NlcQJwdJIp6.FXuxQp9z9H2iflC5x.q70K15HGSxePoW/V5E9kL2Hllx0pRKQkWYCXUH11
Instance 1 33793 MZ92 $KB$Mqh0mH9YyW55CKA0v5/Lr.RL7.mAsxpYyQHmtUW250szh.hwi11qxbk1tditriYRN7bmbz02iel5Ei0
Instance 1 33794 MZ93 $KB$PeqPP61.qRm90d0dtFX5rd3B0j1/s3o58ij/nG4V74V5Zr4JQsvK1My6Sh7doJ2wkGgJo5xG6uhN7vBGHyc./
Instance 1 33795 MZ94 $KB$MQXziNDcn.a.wede0CxXfgZx6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY/ud3a0fuF9yrf/q/PAN9m7McV8fPI0
Instance 1 33796 MZ95 $KB$YZ39okrD6ZwQToJaEPGoeYXAmnPzCrJv6F/78YFipv37B8ITp4PHWsn8saFuePzybq5h9EcGymVLF1Iz.hkpG/
Instance 1 33797 MZ96 $KB$dbtKrxHmuUJUuYvgCae7iQvRuJ6mM3duZzMP4b32pP4M3dfdfgnfh162auhcQbs2ASGLISYqxcUR2jiJLJucA0
Instance 1 33798 MZ97 $KB$h8Du731fK7wBS0d4iYSKd3EgT0R/Vo96ZPdY8iaeEcU3zcf7TbD/0HU1W//zKnZyj2vdP534.4H51GVjwxFu1
Instance 1 33799 MZ98 $KB$45Tt0J7zuRxaqIpfRobVRxkLI.JG1txA7uFL29gR7vj6Lfym33CR5jrtQzLzoe8q1pVkeTh/1ACnd1E2vtCX7.
Instance 1 33800 MZ99 $KB$zk.Aq1ZKbJdJrX3Ynvqj0XGpzHReXwFI09ccoleZ1kCFnvMVDFjWR2nFpXQkzt1SdbPAAmZmUx0DzaS8Vf1
33800 solutions explored
Elapsed Time: 452.626718447s or 7.543778641min
Elapsed Time: 452.628022154s or 7.543800369min
Elapsed Time: 452.629899834s or 7.543831664min
ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 

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5.

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Terminal
ashishshrestha@ashishshrestha: ~/Documents/Assignment>Password_crack/Mpi_Password_Cracking
File Edit View Search Terminal Help
Instance 1 33777 MZ76 $KB$jShOffzN0QH2SojHhRA3.GBwyLfusTIVGiPP8/yghbh9lRE2I8lK8tCIqR9nVY2i0J1PfkLm2m.cm2EnradEY.
Instance 1 33778 MZ77 $KB$scsYGL394iXS/reMbZhDhHsToV0bHzB1x8PjxpqYYtYx054cgNPkq14ziAe0HYLeiUpTSyPrnEb.29ERqlIhJx.
Instance 1 33779 MZ78 $KB$3kDvlwx7Z0XhfHAgyNxcC8WmEgjjs5TiP2aVXPYvh014EvCEUxvUJAm3Cw9.f3rkS03oY6zJ0mTYIbwjMdCs1
Instance 1 33780 MZ79 $KB$VH19yiy1zG4zL7b9e8141II14zYA1glNRPQvAY2jT4V4cQcu1II1mHd14f00zkiR00Eg5686UAOFqd30lRPTHy.
Instance 1 33781 MZ80 $KB$o3nj2XQPth4RTAFJCdxlhrzVXMdleE9y682xg3Q1KRW9mc8jpmds/sl1J8xuE3xtbGjteZhDFMblLltDvyptB1
Instance 1 33782 MZ81 $KB$BdqSFjsgsPCe6wnCyg1LmhLxxGqHNRV9y1t2KvDreF09sQBSnOfqTR/0Hk382sK/dtSAqdz/50.p89nxz50dQT.
Instance 1 33783 MZ82 $KB$hfTsEYQySde/IQ5JlxB4saXNn7WLihsdcbGz6uEGhhGgabd/hAFGK/UqsWkIN4q2waRGGw6l8j/iPAqKKCXku1
Instance 1 33784 MZ83 $KB$rVarl5dJG.KKhS1cA51ciHwpAuahAwUP0nzh.7vSJk7s77PCG.5611fMs5dFnV34Hgq1igteYxeGvqliizqwl1.
Instance 1 33785 MZ84 $KB$xx7B2UUJLDbLLrQ/vkISGC5E4deqh52dg3BRIFCsg/ZtQCqpcFOEsH1H1dNj3b6i8k5f8AR.czDATZjIapn0Q1
Instance 1 33786 MZ85 $KB$v.2vkQ60N84N0cwkhlfH9yyNFze600D9bmalYuf3B8rP1Ra2B2TnCAKuYPCgSnX2iwGpV0eq9e6lyg/kyl
Instance 1 33787 MZ86 $KB$meCi3GrQiuHx19I808lxBLWPxEZ9RsRMvD2Hzu7IB3gbHCxzDj5wHATirVnwj.1Ks/e/5N0lFH8juKKy7pgb9.
Instance 1 33788 MZ87 $KB$ie9jxPZYvfmOUxfEhd5zJymjZjps080kaxD.n0Cjb.vQn2ST.uEed.4Ccb9g0hTmEZzF/FON0xaIsVwU6.sN./
Instance 1 33789 MZ88 $KB$8X8zBoeINIkfU7YyMh5beMu8MPe2Yrl5JJus9hd8zkkPP0tPZHNS5bh.5d5nDN6VF39XuRDkZNMOEtUp01
Instance 1 33790 MZ89 $KB$qe2317y5UfQcU4M/0BwvfEdnTgLGijotbAE70s0raxR1/NR3Vfj4Z/sMYA1Pj6ztPAE82fenkB0re.oK6Eo/
Instance 1 33791 MZ90 $KB$3.3U7tmqRN42wNnJdpQcW8kCGSXZaenksWAkBHHNODxAIEx2f5hab6bjnRUXqvutd9M1iyL20sP/2GTP4FP.
Instance 1 33792 MZ91 $KB$VcYtnJtvPftmQ5NlcQJwdJIp6.FXuxQp9z9H2iflC5x.q70K15HGSxePoW/V5E9kL2Hllx0pRKQkWYCXUH11
Instance 1 33793 MZ92 $KB$Mqh0mH9YyW55CKA0v5/Lr.RL7.mAsxpYyQHmtUW250szh.hwi11qxbk1tditriYRN7bmbz02iel5Ei0
Instance 1 33794 MZ93 $KB$PeqPP61.qRm90d0dtFX5rd3B0j1/s3o58ij/nG4V74V5Zr4JQsvK1My6Sh7doJ2wkGgJo5xG6uhN7vBGHyc./
Instance 1 33795 MZ94 $KB$MQXziNDcn.a.wede0CxXfgZx6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY/ud3a0fuF9yrf/q/PAN9m7McV8fPI0
Instance 1 33796 MZ95 $KB$YZ39okrD6ZwQToJaEPGoeYXAmnPzCrJv6F/78YFipv37B8ITp4PHWsn8saFuePzybq5h9EcGymVLF1Iz.hkpG/
Instance 1 33797 MZ96 $KB$dbtKrxHmuUJUuYvgCae7iQvRuJ6mM3duZzMP4b32pP4M3dfdfgnfh162auhcQbs2ASGLISYqxcUR2jiJLJucA0
Instance 1 33798 MZ97 $KB$h8Du731fK7wBS0d4iYSKd3EgT0R/Vo96ZPdY8iaeEcU3zcf7TbD/0HU1W//zKnZyj2vdP534.4H51GVjwxFu1
Instance 1 33799 MZ98 $KB$45Tt0J7zuRxaqIpfRobVRxkLI.JG1txA7uFL29gR7vj6Lfym33CR5jrtQzLzoe8q1pVkeTh/1ACnd1E2vtCX7.
Instance 1 33800 MZ99 $KB$zk.Aq1ZKbJdJrX3Ynvqj0XGpzHReXwFI09ccoleZ1kCFnvMVDFjWR2nFpXQkzt1SdbPAAmZmUx0DzaS8Vf1
33800 solutions explored
Elapsed Time: 459.813589619s or 7.663559827min
Elapsed Time: 459.814753547s or 7.663579226min
Elapsed Time: 459.816985690s or 7.663616428min
ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 

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6.

```
ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 
File Edit View Search Terminal Help
Instance 2 33777 ZZ76 $6$KB$/oI/6/zBFE5d0ZWnQjX8KqfhiyCeS3rttMpVNciVowhs0bdv2uZgBxZekV4XsDmQX6j6RGYs7mYf1WN/dllS.
Instance 2 33778 ZZ77 $6$KB$bRQ1EfP5K1Voc6KXNx55ikf70TwVmIPZESPztrNGHBNaf9UwGtUoqnw.4CXCEgW6NsneBm8YYWpbir5wpqlJL.
Instance 2 33779 ZZ78 $6$KB$bTgT36YAt8xlpqMgdceBUAngLdYg/hMifqg1XT2CH722XlM2fxJ1ccnXYn.gnGnksYvVPqs0tKqNgBkjwger0
Instance 2 33780 ZZ79 $6$KB$bjs0ufb6Vgy.uFYeY.r5xEBoeAJw0hUXcj7htVsLM6ahexvt3aj4VyhD4nZ3wGrSzTlFAMZlHbj7Ec6Ja9RW0
Instance 2 33781 ZZ80 $6$KB$bNA46P2pAmhjb233D8Q1kUpJepIg1s0PwZdGCeYwuzNptvnCJ8m6nWAbHD0IDiLAJYWaKUp7TiwTbi12.
Instance 2 33782 ZZ81 $6$KB$b93pWA16kS0zyLeETk0jk0x69uF0EB297P.yD4s0YY3oss54B2JFLiLwJ0kjm9g451p.CXFQ0LDFcTdnON0d71
Instance 2 33783 ZZ82 $6$KB$b6CMCMoUrKSt0ALmMYBG3HnFOHqYnIUsEzNg6YbI84Nv4CpUXBynVzv9XdbKt08d07TmhFGSKVSw09ZNZMR//.
Instance 2 33784 ZZ83 $6$KB$b5yvyseEGCALa25V01ntCeKs.CvADKQKpCUg.D./DV0UOPCPJsm1/1nBMsZNf211Gr4p5BeRawtC76jX07jGB1Z.
Instance 2 33785 ZZ84 $6$KB$b55xu.uaA902HKKVft4DuCy's19eKKTExCa/ZlkdcA8KmDQ/LUu4kfsK8A8pqjt4wDVKH2M3ft15X.00ysHP190
Instance 2 33786 ZZ85 $6$KB$b1Pqgw4F2.75K.QfcsDbEsWk0ieRK6DGKAVQyEw56.Duj96PdssQG20x474/VPYF4W7aoYGem8QxIWKMkco.0
Instance 2 33787 ZZ86 $6$KB$b1D/FRKcrM23MB1Is14rjm.DHY3nP109nhYz07459ZXM0RDGj4oW0pURZE6oNVWR13gwRW/NHqaTJLiM.aq070
Instance 2 33788 ZZ87 $6$KB$b98RtAp7wzrIHQQAD62owLTxiMb/B2dsi55ojlyKCR8vB6PGkF3TxaMnZBPO/zuFpPhT9AoSqtBUp7lqUjs3V1
Instance 2 33789 ZZ88 $6$KB$b9u9c6jJpetHtted50sbx0M0U0p0rhn.y5GuqcCSwtSHy/3J2B3i80l0/hMXMYoTFXDD9dSsrtuQBR0/nPu11
Instance 2 33790 ZZ89 $6$KB$b0Czn7XrcDw51/tCcSVYBH4N8h.UE/zill1smfyvgbcfQd8n32fHhewKqInqlg9EGouXyXYQjhjs/9idY.
Instance 2 33791 ZZ90 $6$KB$b.e.amgv0HDo1dybMLGEKQDxyX39mXQzv0GFhkbs2Rpt14J0H2zTREwCBIdoVp.QkWEUrcRo7EHXN3ps0CJNLG1
Instance 2 33792 ZZ91 $6$KB$b2u/y9a0V3DSk3r8LAhqRibl6CpkhLYC9CwUgWe4.QqxmD5bbEvau9gahVvF6T19kQwM9Qc12HGqppIoqoAT.
Instance 2 33793 ZZ92 $6$KB$bEnFr7d7t7X8ZCnld/ekc3H/AV.lxky30EPdTauyRkd667t4rWmtp1bY306oY5Gc.MvU5pkuA5p7cqHPu09qc/
Instance 2 33794 ZZ93 $6$KB$b0zFv/5kUds9Km6ZeZC5az3jv0qnTd3RRnkXqnvzEBPXMkLTDffkP00JKB61KW74M9sf6D3JvQy.cbU5BCR76/
Instance 2 33795 ZZ94 $6$KB$b2afET5X77mspBhEd1hs7cRTU/2cP1bv6K6PMtpf7pbeaqJFdj0poTRHK.7.ZfcTCAUJuav20J8JZb5wBMrt0
Instance 2 33796 ZZ95 $6$KB$bqmB840ZKwv3t2fgJnYawmuglVBqkSzq8RbPyf4IhKfr1fl2XqNm0X1ka1Rzzhev4jxdSpPEuoRMFg0TBblrzJ0
Instance 2 33797 ZZ96 $6$KB$bUrzgUnVyaGjokrg7zk540mE5yYKH0njLUBQfcD4JjmwW60A/1.aq984tnjvwjCC0Rt6/MNg46CFLZyad9f1
Instance 2 33798 ZZ97 $6$KB$bMil6hksBE0YCD/FxJN0tIhRbPT6t0jwau37zhmlEJKXnpqfb1VBHLVdGe5411e3NFcNx10cz6vp2jwKrLb0
Instance 2 33799 ZZ98 $6$KB$beve8v4J8QPlznp9U0BmugDaR0W7vnUpY48lvc.09qaCaVWoRVukxmUwP1Mf320SpjtFzd6zugsi9129QNb./
Instance 2 33800 ZZ99 $6$KB$b5n.Yjw98UBTw/k8Ifvb5rTozwkjI/UylKkvNQEyg1pHCzJmcN8dH7431TL2GvrXJaACBBHno2x6ugcYkaSrf1
33800 solutions explored
Elapsed Time: 450.135805020s or 7.502263417min
Elapsed Time: 450.138745586s or 7.502312426min
Elapsed Time: 450.138052623s or 7.502300877min
ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 
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7.

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ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 
File Edit View Search Terminal Help
Instance 1 33777 MZ76 $6$KB$bJSh0ffzN00H2SojHhRA3.GBwyLfusTIVGiPP8/yghbh9lRE2I8lKt8C1qR9nVY2i0j1PfkLm2m.cm2EnradEY.
Instance 1 33778 MZ77 $6$KB$bScsYGL394iXS/reMbZhDhTsToV0bHzB1x8PjxpdgYttYx054cgNPKqj4i2Ae0HyeLiUpTSyPrnEb.29ERql1hJx.
Instance 1 33779 MZ78 $6$KB$b3kdlwx7Z0XhfHAgyNxc8WmEgjjs5TIp2aVXPVvh014EvCUEuxuVUJm3Cw9.f3rkS03oY6zJ0mTYIbwjMdCs1
Instance 1 33780 MZ79 $6$KB$bVHi9yiyZG4L7b8E14115I4zYA1glRNPQvqAY2jT4V4cQcP1II1hd14f00zK1R00eg5686UAOFQd30lRPThy.
Instance 1 33781 MZ80 $6$KB$b03nj2X0Pth4RTAFJCdxlhrzvXMDleE9y682xg3Q1K1Rw9mc8jpmDs/sl1J8xuE3xtb0jteZhdFmblLltvypbt81
Instance 1 33782 MZ81 $6$KB$bBdgSFjsgsPCe6wnCyg1LhmLxXgqHNrvY9lt2KvDrF09sQBSn0FqTR/0Hk382sk/dtsAqdz/50.p89nxz50d0T.
Instance 1 33783 MZ82 $6$KB$hfTsEYQySde/IQ5JlXb4saXnn7WLihsdBcGz6uEghhGGabd/hAFGK/uQswkIN4q2waRGW6l8j/iPAqKKCkxu1
Instance 1 33784 MZ83 $6$KB$bRqvarl5dJG.KKhSlcA51ciHwpAuHwUP0nzh.7vSJk7s77PCG.561lfMs5dFnV34HgqligteYxeGvql1zqwl1.
Instance 1 33785 MZ84 $6$KB$bxx72UUJLbLlrQ/vkISGc5E4deqh52dg3BRIFCsg/ZtQcpcFOEsH1H1dNj3b6i8k5f8AR.czDATzjIanp0Q1
Instance 1 33786 MZ85 $6$KB$b5v.2vkQ60N84N0cwkh1vFH9ynYfze600D9bm1alYf3B8R+P1Ra2B2TncAkUyPcgsXk2iwpv0eq9e6lyg/ky1
Instance 1 33787 MZ86 $6$KB$bmeCi3GrQiuHx19I18081xBwpxEz9HsRmvD2H2zu7Ib3gBhcxZdj5wHATirVnwj.1Ks/e/5N0lF8juKky7gb9.
Instance 1 33788 MZ87 $6$KB$bie9jxPZYvfmOufxehd5zjymjZjps080kaxD.n0Cjb.vQn2ST.uEed.4Ccb9gh0tMeZZf/F0N0xaIsVwU6.sN./
Instance 1 33789 MZ88 $6$KB$b8XzBoeINIkfUfYt7YmH5bMod8MPe2Yr15JJus9hd8zkkpp0tPzhN5Bhm.5d5nD6VF39XuRDKZNM0EtUp01
Instance 1 33790 MZ89 $6$KB$bqe2317Y5ufQcU4M/BQWvFEdnTgLgijtBQAE70s0raxR1/Nr3Fj4Z/sMYA1Pj6ztPAE82fenkbQre.oK6Eo/
Instance 1 33791 MZ90 $6$KB$b3.3U7tmqRN42wNnJdpQcW8kCGSXrzaenksAWbkhn0DxAIEEx2f5hab6bjnRUxqvutvd9M1iyL20sP/2GTP4FP.
Instance 1 33792 MZ91 $6$KB$bVytwnJtvPftmQ5NlcQJwdJp6.FXuxQp9zH2ifLc5x.q70K15HGSxePoW/v5E9kL2Hllx0pRkQkWycxuhi1
Instance 1 33793 MZ92 $6$KB$bMqh90mH9Yw55CkA0V5/lr.RL7M.gASrpxpYQHmtW250sZ.hwiK1I1qxbk1tvditriYRNR7mbz021ie15Ei0
Instance 1 33794 MZ93 $6$KB$bPeqPP61.qRm90d0dtFx5rd3B0j1/s3o58ij/nG4V74V5ZR4JQsvK1My6Sh7doJ2wkGgjo5xG6uhN7vBGHyHc./
Instance 1 33795 MZ94 $6$KB$bMQxzidNcn.A/wede0CxXfgZx6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY.ud3a0fuF9yrf/q/PAN9m7McV8fPi0
Instance 1 33796 MZ95 $6$KB$bYZ39okrD6ZwQToJaEPGoeYXAmprZCrJv6F/78YFipv37B8ITp4PHWsn8safUePzybq5h9EcGymVLF1Iz.hkpG/
Instance 1 33797 MZ96 $6$KB$bdtKrxHmuJUuYvgCae7iQvRuJ6mM3duZzMP4b32p4M3dfFgnfh162auhcQbs2ASGLISYqxcUR2j1JLJucA0
Instance 1 33798 MZ97 $6$KB$b8H8D731fK7wB50d4iYskd3Eg70R/Vo96ZPdY8iaEcZU3zcf7tBd/0HU1w//zKnZyj2vdP534.4H51GVjwxFu1
Instance 1 33799 MZ98 $6$KB$b45Tt0j7ZuRxqIpfRobVrxkli.JG1tx7uFL29gR7vJ6Lyfym33CR5jrtQzLzo8eq1pVKEth/1ACnd1E2vtCx7.
Instance 1 33800 MZ99 $6$KB$bKz.Aq1ZKbJdJrX3Ynvqj0xGpzHRExwFIQ9ccoleZ1kCFnvMVDFjWR2nFpXQkzt1SdbPAAmZmUx0DzaS8VfJ1
33800 solutions explored
Elapsed Time: 453.292350263s or 7.554872504min
Elapsed Time: 453.291143971s or 7.554852400min
Elapsed Time: 453.290535647s or 7.554842261min
ashishshrestha@ashishshrestha:~/Documents/Assignment>Password_crack/Mpi_Password_Cracking$ 
```

8.

```

ashishshrestha@ashishshrestha: ~/Documents/Assignment/Password_crack/Mpi_Password_Cracking
File Edit View Search Terminal Help
Instance 1 33777 MZ76 $6$KB$jShOffzN00H2SojHhRA3.GBwyLfusTIVGiPP8/yghbh9lRE2I8lK8tCIqR9nVY2i0J1PfkLm2.cm2EnradEY.
Instance 1 33778 MZ77 $6$KB$cYGL394iXS/reMbZhDhHsToV0bHzB1x8pjxpqYYtYxQ54cgNPKqiq4ziAe0HYelUpTSyPrnEb.29ErqlJhJx.
Instance 1 33779 MZ78 $6$KB$3kDvlwx7Z0XhfHAgycNxcC8wMEqj5STip2aVXPYvh014EvCUExvUJAm3Cw9.f3rkS03oY6zJ0mTY1bwjMdCs1
Instance 1 33780 MZ79 $6$KB$VHi9yizGzL7b9E8141I5I4zYA1glNRPRQVqAY2jT4V4cQcu1II1mHd14f00zKiR00Eg5686UACFQd30lRPTThy.
Instance 1 33781 MZ80 $6$KB$o3nj2X0Pth4RTAFJCdxlhrzVXMdleE9y682xg30K1R9mc8jpmDs/s11J8xuE3xtbGjteZhDFMblLltdVypTB1
Instance 1 33782 MZ81 $6$KB$BdqSFjsgsPCe6wnCygLMxXGqHNRVY91t2KvDRf09sQBSn0FqTR/HKj82sK/dTSAqdZ/50.p89nxz5QdQT.
Instance 1 33783 MZ82 $6$KB$hfTsEYQsdeIQ5jlXb4saXn7WLIshtbcGz6uEghhGabd/hAFGK/UQsWkIN4q2waRGW6l8j/iPAqKKCXku1
Instance 1 33784 MZ83 $6$KB$rQvarl5dJG.KKh51cA51ciHwpuAwUpOnzh.7vSJk7s77PCG.561lfMs5dFDNV34HGq1igteYevGvqliZqw1.
Instance 1 33785 MZ84 $6$KB$xx7B2UU1LDblLr0/VkISGC5E4deqh52dg3BRIFCsg/ZtQCpcF0EsH1H1dnJ3b6i8k5f8AR.czDATZjIapn0Q1
Instance 1 33786 MZ85 $6$KB$b.v.zvkQ60N84N0cwKhlVFH9yyNfze600D9bmalsYuf3BrPr1Ra2B2TNCuAypCgsX2iwpV0e0g9e6lyg/kyl
Instance 1 33787 MZ86 $6$KB$bmeCi3GrQiuHx191808lxBlWPxEZ9RsRMvD2Hzu7IB3gbCHxZdj5wHATirvnwj.1ks/e/5N0lFH8juKKy7Pgb9.
Instance 1 33788 MZ87 $6$KB$be9jxPZYvfmOUXFehdzJymjZjps080kaxd.n0Cjb.vQn2St.Ued.4Cc9g0hTmEZff/FON0xaIsVwU6.s.n./
Instance 1 33789 MZ88 $6$KB$8XzBoeINIKfFuTx7YMvH15beMuD8MPe2Yrl5JJus9dh8zkkPP0tPZHN5Bhm.5d5nDN6VF39XuRDKZNm0EtUp01
Instance 1 33790 MZ89 $6$KB$qe2317YvU4M/0BwfpEdnTgLgiotbAQE70s0raxR1/NR3Vfj4z/sMYA1Pj6ztPAE82fenkB0re.ok6Eo/
Instance 1 33791 MZ90 $6$KB$3.3U7tmqRN42wNnJdpQcW8kcGSXRZaenksWAVbKHNDQxAIEx2f5h6bjnRUxqvvt9M1iyL20sP/2GTP4FP.
Instance 1 33792 MZ91 $6$KB$VcyTwnJtvPftmQ5Nlc0JwdJIp6.FXuxOpz9H2ifLC5x.q7OK15HGSxePoW/v5E99L2H1lx0pRKQkWYCXUHI1
Instance 1 33793 MZ92 $6$KB$Mqh90mH9Yww5ScKA0v5/Lr.rLM7.gASrxpWYQhMtUW250szh.HwiK1IqxbK1tvdtitriYRNR7bmbzQ1iel5E10
Instance 1 33794 MZ93 $6$KB$PeqPP61.qRm90d0dtFx5r3D0j1/s3058ij/nG4V74V5ZR4JQsV1My6Sh7doJ2wkGgJ05xG6uhN7vBGHYHc./
Instance 1 33795 MZ94 $6$KB$MQXziNDCh/a/wede0OCxxfgZx6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY/ud3a0fuF9yrf/q/PAN9m7McV8fPI0
Instance 1 33796 MZ95 $6$KB$YZ39okrD6ZwQToJaEPgoeYXAmprZCrJ6F/78Fipv37B8iTp4PHwsn8saFuePzybq5h9EcGymVLF1Iz.hkpG/
Instance 1 33797 MZ96 $6$KB$dbtKrxhMuJUuYvgCAe7iQvRuJ6mM3duZzMP4b32pP4M3DfdFgnfh162auHc0bs2ASGLISYqxUR2jJLJUCa0
Instance 1 33798 MZ97 $6$KB$h8Du73lFK7wBs0D4iYSkd3EgT0R/Vo96ZPdy8iaEcUz3cfT7bD/0HU1W//zKnZyj2VdP534.4H51GVjwxFu1
Instance 1 33799 MZ98 $6$KB$#45Tt0J7zurXaqIpfRobVRxkLI.JG1tXa7uFL29gR7vJ6LfyM33CR5jrtQzLzoe8q1pVkEth/1ACnd1E2vtCX7.
Instance 1 33800 MZ99 $6$KB$Kz.Aq1ZKbjDjrX3Ynvqjo0XGpzHReXwFIQ9ccoleZ1kCXFnvMVDFjWR2nFpXQkz1SdbPAAMzmu0DzaS8VfJ1
33800 solutions explored
Elapsed Time: 458.322298452s or 7.638704974min
Elapsed Time: 458.321955621s or 7.638699260min
Elapsed Time: 458.325443892s or 7.638757398min
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/Mpi_Password_Cracking$ 

```

9.

```

ashishshrestha@ashishshrestha: ~/Documents/Assignment/Password_crack/Mpi_Password_Cracking
File Edit View Search Terminal Help
Instance 2 33777 ZZ76 $6$KB$/oI/6/zBFEd0ZWnQjX8KqfhiyZeS3rttMpVNciVowhs0bdv2uZgbxZekV4xsDmQX6j6RGYs7mYf1WN/dLLs.
Instance 2 33778 ZZ77 $6$KB$rQ1EfP5K1Voc6KXNx55ikf70TwVmIPZESPztrNGHBNaf9uWgtUoqnw.4CXCEgW6NsneBm8YYwPpbir5wpqlJ1.
Instance 2 33779 ZZ78 $6$KB$eTgT36YAt8xlpqMgdceBUAngLdYg/hMifqg1XT2CH722XLM2fXJ1ccnXyN.gnGnKsYvVPqsQtKqNgBkjwger0
Instance 2 33780 ZZ79 $6$KB$js0ufb6Vgy.uFYr.YsEB0eAjw0hUXcj7htVsLm6ahexvt3aj4YvDH4nZw3rBq7t4wDKM2fX7Ec6Ja9RW0
Instance 2 33781 ZZ80 $6$KB$KNA46P2pAMhbz233D801kJupJepIgls1ePwZdGceYlwuzNptvnCJ8m6nWDAbHD0IDIlaJYwAKupt7IwTb12.
Instance 2 33782 ZZ81 $6$KB$o93pWA16kSozyleETk0jk0x69uF0EB297P.yD4s0YYV3oss54B2JFl1iuj0kjm9g451p.CXFQ00LDFcTdnON0d71
Instance 2 33783 ZZ82 $6$KB$i6CMCMoUrKst0ALmMYBG3HnFOHqYnIUsSeZNg6YbI84Nv4CpUXBynVzv9Xdbkt08d07TmhFGSKVSw09ZnZMR//.
Instance 2 33784 ZZ83 $6$KB$bvyseEGCALa25V01ntCeKs.CvADKQKpCUG/D./DV0UOPCPjsm1/1nBmsZNF211G4p5BeRawtC76jX07jGB1Z.
Instance 2 33785 ZZ84 $6$KB$S5xu.uaAA902HKKVFT4DuCyYs19eKkteXCa/ZlkC8KmDQ/LUU4kfsK8A8pqjt4wDVKHM2M3ft15X.00ysHPI90
Instance 2 33786 ZZ85 $6$KB$1Pqgw4F7.75K/qfcBdsBwkoieRk6DGAVkyEw56.Duj96PdsQG20x474/VYYF4W7aoYGem8QxIWKMkco.0
Instance 2 33787 ZZ86 $6$KB$alD/FRKcrM23MB1iSi4jm.DHY3nP109nyhZ07459ZXM0RDGj4oWopUrzE6oNVWRI3gwRW/NHqaTJLiM.aq070
Instance 2 33788 ZZ87 $6$KB$98RtAp7wZrIHQQAd62owLTxiMb/B2si55jlyKCR8vB6PGkf3TxAxnzbpo/2uFpPhT9AoSqtBup7lqUjs3V1
Instance 2 33789 ZZ88 $6$KB$b9u0c6j1petHtted5g0sBx0M0Bup09r5yGuQcSWTSHy/3J2B180l9/hMXMY0TFXDD9dssrTuQBRQ/Pu11
Instance 2 33790 ZZ89 $6$KB$C0zn7XrcDiW5/tCCxSVBHN4N8h.UE.zillIsmfyvgbcfQdS8n3zfHhewKqInqlg9EG0uXyXYQjHjs/9idY.
Instance 2 33791 ZZ90 $6$KB$e.amgv0H0do1yblMLGEKQDxyX39mXQzv0GFhKb3z2Rpt14J0H2zTREwCBIodVp.QkWEurcRo7EhXN3ps0CJNLG1
Instance 2 33792 ZZ91 $6$KB$e2u/y9a0V3DSk3r8LAhqRibl6CpkhLYC9CwUgWe4.QqxmD5bbEvau9gahVvF6Ti9kQwM9Q12HGqppIoqoAT.
Instance 2 33793 ZZ92 $6$KB$EnFr7d17t8ZCnld/ekc3H/AV.lxky30EPdTauyD667t4r4wMtp1bY3060y5gC.MvU5pkua5p7cqHPu09q/C/
Instance 2 33794 ZZ93 $6$KB$0zFv/5kUDsa9km6ZeZC5az3jV0qnTdRrnKxqnvEBPXMkLdTdfkP00JKB6Lkw74M9sf6D3JvQy.cbU5BCR76/
Instance 2 33795 ZZ94 $6$KB$ZafET5X7TmsPbHed1hs7cRTU/2cPiBvr6KGoPMtpfpe9AJFdj0p0tRHK.7.ZfcTCAUJuav20J8J2b5wBMr0
Instance 2 33796 ZZ95 $6$KB$qmB840ZKwv3t2fgJnYawmugLBjkSzq8RbPyf4IhKfr1fl2xqNMox1kalRzzhve4jxdSpPEuoRMFgoTBblzrJ0
Instance 2 33797 ZZ96 $6$KB$uRZgUnVyaGjKrg7zk540mE5yYKH0njLUBQfc04Jjmjw6m0A/1.aq984tnjvwjCC0RtG/MNg46CFLZyad9f1
Instance 2 33798 ZZ97 $6$KB$M16hksBWE0YCD/FxJN0tIhRbPT6t0jwauj37zhmlEJKxNpqfb1VBHLVdGe5411e3NFcNXi10cz6vp2jwKrLb0
Instance 2 33799 ZZ98 $6$KB$eve8v4J8QPlznp9u0BmugDaR0W7VnUpY48lvc.09qaCaVWw0RvukxmUwP1Mf320SpjtFzd6zugsi9129QNb./
Instance 2 33800 ZZ99 $6$KB$n.Yjw98UBTb/k8IfVb5rTzowkjI.UyYlKkvNOEygLPHCZjmcN8dH7431TL2GvrxjaACBBHnoZx6ugcYkaSrf1
33800 solutions explored
Elapsed Time: 455.466813715s or 7.591113562min
Elapsed Time: 455.462217510s or 7.591036959min
Elapsed Time: 455.457564605s or 7.590959410min
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/Mpi_Password_Cracking$ 

```

## 10.

```
ashishshrestha@ashishshrestha: ~/Documents/Assignment/Password_crack/Mpi_Password_Cracking
```

File Edit View Search Terminal Help

```
Instance 1 33777 MZ76 $6$KB$jSh0FfzN00H2SojHhRA3.GBwyLfusTIVGiPP8/yghbh9lRE2I8lK8tCIqR9nVY2i0J1PfkLm2m.cm2EnradEY.  
Instance 1 33778 MZ77 $6$KB$scYGL394iXS/reMbZhDhHsToV0bHzB1x8PjxpqYYtYxQ54cgNPKqi4ziAe0HYeLiUpTSyPrnEb.29ErqlIhJx.  
Instance 1 33779 MZ78 $6$KB$3kDvlwx7Z0XhfHAgYNxcc8wM EgjjsSTip2aVXPYvh014EvCUExvVUJam3Cw9.f3rkS03oY6zJ0mTY1bwjmDcS1  
Instance 1 33780 MZ79 $6$KB$VHi9yizG4zL7b9E8141I5I4zYA1glNRPQVqAY2jT4V4cQcu1II1mHd14f00zKiR00Eg5686UACFQd30lRPThy.  
Instance 1 33781 MZ80 $6$KB$o3nj2X0Pth4RTAFJcdxlhrzVXMdleE9y682xg3QK1R9mc8jpmDS/s11J8XuE3xtbGjteZhDFMblLltdvypb1  
Instance 1 33782 MZ81 $6$KB$BdqSFjsgsPCe6wnCyg1HmLxXGqHNRVY9lt2KvDReFO9sQBSn0FqTR/0HKj82sK/dTSAqdZ/50.p89nxz5QdQT.  
Instance 1 33783 MZ82 $6$KB$hfTsEY0Ysde/IQ5jlXb4saXn7WL Ih5dbcGz6uEghhGabd/hAFGK/UqsWkIN4q2waRGW6l8j/iPAqKKCXku1  
Instance 1 33784 MZ83 $6$KB$rQvarl5dJG.KKh51cA51ciHWpAuHwUPOnzh.7vSJ7s77PCG.561lfMs5dFnV34Hgq1ligteYxeGvqlIiZqw1.  
Instance 1 33785 MZ84 $6$KB$xx7B2UUJLDbLLr0/VkISGC5E4deqh52dg3BRIFCsg/ZtQCqpcF0EsH1H1dNj3b6i8k5f8AR.czDATZjIanp0Q1  
Instance 1 33786 MZ85 $6$KB$b/.ZvkQ60N84N0cwKh1VFH9yynYFze600DJ9bmalYuf3BrRp1Ra2B2TnCAKuYPcgSnX2iw6pV0e0g9e6lyg/ky1  
Instance 1 33787 MZ86 $6$KB$meCi3GrQuiHx19I808lxBlWPxEZ9HsRMvD2Hzu7IB3gBHCxZdj5wHATirVnwj.1Ks/e/5N0lFH8juKKy7Pgb9.  
Instance 1 33788 MZ87 $6$KB$bie9jxPZYvfmOUXFHd5zJymjZjps080kaxd.n0CJb.vQn2ST.uEd.4Cc89g0HtmEZff/FON0xaISvWU6.s.N./  
Instance 1 33789 MZ88 $6$KB$8XzBoeINIKfFUxT7YMvH15beMuD8MPe2Yrl5JJus9dh8zkkPP0tPZHN5Bhm.5d5nDN6VF39XuRDKZNm0EtUp01  
Instance 1 33790 MZ89 $6$KB$qe2317Y5Uf0cu4M/QBVVfEdnTgLgiJotbAQE70s0raxR1/NR3VFj r4Z/sMYA1Pj6ztPAE82fenkB0re.0k6Eo/  
Instance 1 33791 MZ90 $6$KB$.3U7tmqRN42wNnJdpQCw8kcGSXRZaenksWAVbKHHDQxAIEx2f5Hab6bjnRUxqvvtD9M1iyL20sP/2GTP4FP.  
Instance 1 33792 MZ91 $6$KB$VcYtwnJtvPftmQ5Nlc0JwdJIp6.FXuxOp9z9H2ifLC5x.q7OK15HGSxePoW/V5E9KL2Hllx0pRKQkWYCXUHI1  
Instance 1 33793 MZ92 $6$KB$Mqh90mH9Yww5ScKA0v5/Lr.rLM7.gASrxpWYQhMtUW250szh.HwiK1IqxbK1tvdtiriYRNR7bmbzQz1iel5E10  
Instance 1 33794 MZ93 $6$KB$PeqPP61.qRm90d0dtFXr3B0jI/s3o58ij/nG4V74V5ZR4JQsvK1My6Sh7doj2wkGgJ05xG6uhN7vBGHYHc./  
Instance 1 33795 MZ94 $6$KB$MQxiNDCh.a/wede0CXxfGzX6EPIDj7gKhkrNgpt7dhMDHif7M.HUFLY/ud3a0fuF9yrf/q/PAN9m7McV8fpI0  
Instance 1 33796 MZ95 $6$KB$YZ39okrD6ZwQToJaEPgoeYXAmpnZCrJv6F/78YFipv37B8ITp4PHWsn8saFuePzybq5h9EcGymVLF1Iz.hkpG/  
Instance 1 33797 MZ96 $6$KB$dbtKrxhMmUJUuYvgCae7iQvRuJ6mM3duZzMP4b32pP4M3DfdFgnfh162auHc0bs2ASGLISYqxUR2JiJLJucA0  
Instance 1 33798 MZ97 $6$KB$h8Du731fK7wBs0D4iYSkd3EgT0R/Vo96ZPdY8iaEcZU3zcfT7bD/0HU1W//zKnZzYj2VdP534.4H51GVjwxFu1  
Instance 1 33799 MZ98 $6$KB$45tf0J7ZuRxqIpfRobVRxkLI.JG1tXa7uFL29gR7vj6Lfym33CR5jrtQzLzoe8q1pVkEth/1ACnd1E2vtCx7.  
Instance 1 33800 MZ99 $6$KB$Kz.Aq1ZKbJdJrX3YnvqJo0XGpzHReXwFIQ9ccoleZ1kCXFnvMVDFjWR2nFpXQkzt1SdbPAAmZmUx0DzaS8VfJ1  
33800 solutions explored  
Elapsed Time: 457.408307580s or 7.623471793min  
Elapsed Time: 457.407004907s or 7.623450082min  
Elapsed Time: 457.406545198s or 7.623442420min  
ashishshrestha@ashishshrestha:~/Documents/Assignment/Password_crack/Mpi_Password_Cracking$
```

## Time taken by Image Processing MPI version program.

1.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 604B/s 0B/s 66% File Edit View Search Terminal Help 6CS005 Image P. [● ● ●] all was an abnormal termination. Hence, the only error receive is this one. This terminates other processes in the application to be terminated by signals sent by mpiexec (as reported here). You can avoid this message by specifying -quiet on the mpiexec command line. ----- ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi image dimensions 100x72 image dimensions 100x72 image dimensions 100x72 image dimensions 100x72 ----- [[20254,1],0]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces: Module: OpenFabrics (openib) Host: ashishshrestha Another transport will be used instead, although this may result in lower performance. NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0. ----- image dimensions 100x72 Time elapsed was 154116ns or 0.000154116s
```

2.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 1.78KB/s 0B/s 66% File Edit View Search Terminal Help 6CS005 Image P. [● ● ●] This terminates other processes in the application to be terminated by mpiexec (as reported here). You can avoid this message by specifying -quiet on the mpiexec command line. ----- [ashishshrestha:15903] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics [ashishshrestha:15903] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi image dimensions 100x72 ----- [[20274,1],0]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces: Module: OpenFabrics (openib) Host: ashishshrestha Another transport will be used instead, although this may result in lower performance. NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0. ----- Time elapsed was 158521ns or 0.000158521s
```

### 3.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 826B/s 0B/s 66%  
File Edit View Search Terminal Help  
6CS005 Image P...  
This terminal has 2 processes in the application to be sent by mpiexec (as reported here).  
You can avoid this message by specifying -quiet on the mpiexec command line.  
-----  
[ashishshrestha:15923] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics  
[ashishshrestha:15923] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages  
ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi  
image dimensions 100x72  
-----  
[[20294,1],1]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces:  
Module: OpenFabrics (openib)  
Host: ashishshrestha  
  
Another transport will be used instead, although this may result in lower performance.  
  
NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0.  
-----  
Time elapsed was 199504ns or 0.000199504s
```

### 4.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 2.27kB/s 0B/s 66%  
File Edit View Search Terminal Help  
6CS005 Image P...  
This terminal has 2 processes in the application to be sent by mpiexec (as reported here).  
You can avoid this message by specifying -quiet on the mpiexec command line.  
-----  
[ashishshrestha:15943] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics  
[ashishshrestha:15943] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages  
ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi  
image dimensions 100x72  
-----  
[[20314,1],0]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces:  
Module: OpenFabrics (openib)  
Host: ashishshrestha  
  
Another transport will be used instead, although this may result in lower performance.  
  
NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0.  
-----  
Time elapsed was 170938ns or 0.000170938s
```

## 5.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 1.52KB/s 0B/s 66 %  
File Edit View Search Terminal Help  
6CS005 Image P... 6CS005 Image P... 6CS005 Image P...  
This terminal her processes in the application to be sent by mpiexec (as reported here).  
You can avoid this message by specifying -quiet on the mpiexec command line.  
-----  
[ashishshrestha:15963] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics  
[ashishshrestha:15963] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages  
ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi  
image dimensions 100x72  
-----  
[[20334,1],0]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces:  
Module: OpenFabrics (openib)  
Host: ashishshrestha  
  
Another transport will be used instead, although this may result in lower performance.  
  
NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0.  
-----  
Time elapsed was 440511ns or 0.000440511s
```

## 6.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 2.21KB/s 0B/s 66 %  
File Edit View Search Terminal Help  
6CS005 Image P... 6CS005 Image P... 6CS005 Image P...  
This terminal her processes in the application to be sent by mpiexec (as reported here).  
You can avoid this message by specifying -quiet on the mpiexec command line.  
-----  
[ashishshrestha:15983] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics  
[ashishshrestha:15983] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages  
ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi  
image dimensions 100x72  
-----  
[[20354,1],0]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces:  
Module: OpenFabrics (openib)  
Host: ashishshrestha  
  
Another transport will be used instead, although this may result in lower performance.  
  
NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0.  
-----  
Time elapsed was 490878ns or 0.000490878s
```

7.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 3.18kB/s 0B/s 66% File Edit View Search Terminal Help 6CS005 Image P... This term: Wolverhampton Crown & County Court Wolverhampton Crown & County Court her processes in the application to be sent by mpiexec (as reported here). You can avoid this message by specifying -quiet on the mpiexec command line. [ashishshrestha:16003] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics [ashishshrestha:16003] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi image dimensions 100x72 [[20374,1],0]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces: Module: OpenFabrics (openib) Host: ashishshrestha Another transport will be used instead, although this may result in lower performance. NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0. Time elapsed was 1663067ns or 0.001663067s
```

8.

```
Unknown सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 1.45kB/s 0B/s 66% File Edit View Search Terminal Help 6CS005 Image P... This term: Wolverhampton Crown & County Court Wolverhampton Crown & County Court her processes in the application to be sent by mpiexec (as reported here). You can avoid this message by specifying -quiet on the mpiexec command line. [ashishshrestha:16023] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics [ashishshrestha:16023] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi image dimensions 100x72 [[20394,1],0]: A high-performance Open MPI point-to-point messaging module was unable to find any relevant network interfaces: Module: OpenFabrics (openib) Host: ashishshrestha Another transport will be used instead, although this may result in lower performance. NOTE: You can disable this warning by setting the MCA parameter btl_base_warn_component_unused to 0. Time elapsed was 300530ns or 0.000300530s
```

9.

Unknown

सोम 12:06 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI 2.28kB/s 0B/s 66 %

File Edit View Search Terminal Help

6CS005 Image P... ● ●

This terminal window has two tabs open, both titled "Wolverhampton Crown & County Court". The first tab shows a small icon of a person walking.

Another processes in the application to be sent by mpiexec (as reported here).

You can avoid this message by specifying -quiet on the mpiexec command line.

---

```
[ashishshrestha:16043] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:16043] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi
image dimensions 100x72
[[20414,1],0]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:
```

---

```
Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
```

---

```
Time elapsed was 469621ns or 0.000469621s
```

10.

File Edit View Insert Terminal Help

ashishshrestha@ashishshrestha: ~/Documents/Assignment/014/ip-MPI

This terminal window has two tabs open: "6CS005 Image Processing" and "MPI Application". The "MPI Application" tab is active.

Both tabs show the same message:

Wolverhampton  
Crown & County  
Court

Wolverhampton  
Crown & County  
Court

ether processes in the application to be sent by mpiexec (as reported here).

You can avoid this message by specifying -quiet on the mpiexec command line.

```
[ashishshrestha:16063] 4 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:16063] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/Assignment/014/ip-MPI$ mpiexec -n 5 ./ip_coursework_014_mpi
image dimensions 100x72
-----
[[20166,1],0]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
Time elapsed was 458685ns or 0.000458685s
```

Time taken by Linear regression MPI version program.

1.

```
Terminal शनि 2:54 अपराह्न
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpicc -o lr_coursework_mpi 'lr_coursework_mpi.c'
' -lm
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[23597,1],4]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 350617769ns or 0.350617769s
[ashishshrestha:11564] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11564] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$
```

2.

```
Terminal शनि 2:54 अपराह्न
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 350617769ns or 0.350617769s
[ashishshrestha:11564] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11564] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[23642,1],1]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 350534225ns or 0.350534225s
[ashishshrestha:11611] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11611] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$
```

3.

```
Terminal शनि 2:54 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 350534225ns or 0.350534225s
[ashishshrestha:11611] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11611] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[23674,1],0]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 325625286ns or 0.325625286s
[ashishshrestha:11643] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11643] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```

4.

```
Terminal शनि 2:54 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 325625286ns or 0.325625286s
[ashishshrestha:11643] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11643] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[23706,1],2]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 365351802ns or 0.365351802s
[ashishshrestha:11675] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11675] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```

5.

```
Terminal शनि 2:54 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 365351802ns or 0.365351802s
[ashishshrestha:11675] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11675] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[23751,1],1]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 321015101ns or 0.321015101s
[ashishshrestha:11718] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11718] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```

6.

```
Terminal शनि 2:54 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 321015101ns or 0.321015101s
[ashishshrestha:11718] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11718] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[23783,1],1]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 369546042ns or 0.369546042s
[ashishshrestha:11750] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11750] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```

7.

```
Terminal शनि 2:54 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 369546042ns or 0.369546042s
[ashishshrestha:11750] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11750] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[24327,1],0]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 385449326ns or 0.385449326s
[ashishshrestha:11782] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11782] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```

8.

```
Terminal शनि 2:54 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 385449326ns or 0.385449326s
[ashishshrestha:11782] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11782] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[24358,1],1]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 325763605ns or 0.325763605s
[ashishshrestha:11815] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11815] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```

9.

```
Terminal शनि 2:55 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 325763605ns or 0.325763605s
[ashishshrestha:11815] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11815] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[24390,1],1]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 362917380ns or 0.362917380s
[ashishshrestha:11847] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11847] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```

10.

```
Terminal शनि 2:55 अपराह्न ashishshrestha@ashishshrestha: ~/Documents/HPC_Cousework/linear-014/lr-MPI
File Edit View Search Terminal Help
Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 362917380ns or 0.362917380s
[ashishshrestha:11847] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11847] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ mpiexec -n 9 ./lr_coursework_mpi
-----
[[24422,1],0]: A high-performance Open MPI point-to-point messaging module
was unable to find any relevant network interfaces:

Module: OpenFabrics (openib)
Host: ashishshrestha

Another transport will be used instead, although this may result in
lower performance.

NOTE: You can disable this warning by setting the MCA parameter
btl_base_warn_component_unused to 0.
-----
minimum m,c is 1.420000,36.180000 with error 9.786435
Time elapsed was 348054527ns or 0.348054527s
[ashishshrestha:11879] 8 more processes have sent help message help-mpi-btl-base.txt / btl:no-nics
[ashishshrestha:11879] Set MCA parameter "orte_base_help_aggregate" to 0 to see all help / error messages
ashishshrestha@ashishshrestha:~/Documents/HPC_Cousework/linear-014/lr-MPI$ 
```