Project report for

Project 2: MULTI-THREADED COLLATZ STOPPING TIME GENERATOR

Course: COP 5990

CS Foundations: OS & Networks

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Introduction: In this project, we have created some threads and calculate the collatz sequence of the numbers given from commandline argument. The number of threads to create also given from commandline argument of the program. The program should use mutex_lock to update the global COUNTER variable. Though a –nolock argument is optional to address the race condition when two threads access the COUNTER variable in the same time. These things are done in the problem given in the .zip file.

Race condition: Race condition happens when two threads are access the same memory or try to change the same location of a memory in the same time. In mt-collatz program this problem can be seen if anyone run the program with –nolock optional argument in the commandline. Using –nolock the program don't use the mutex_lock when increasing the global COUNTER variable and also when writing the stopping time to the histogram array. What mutex_lock does is that it's do the operation within the lock mutually exclusively so that not more than one thread can do the process that is within the mutex_lock.

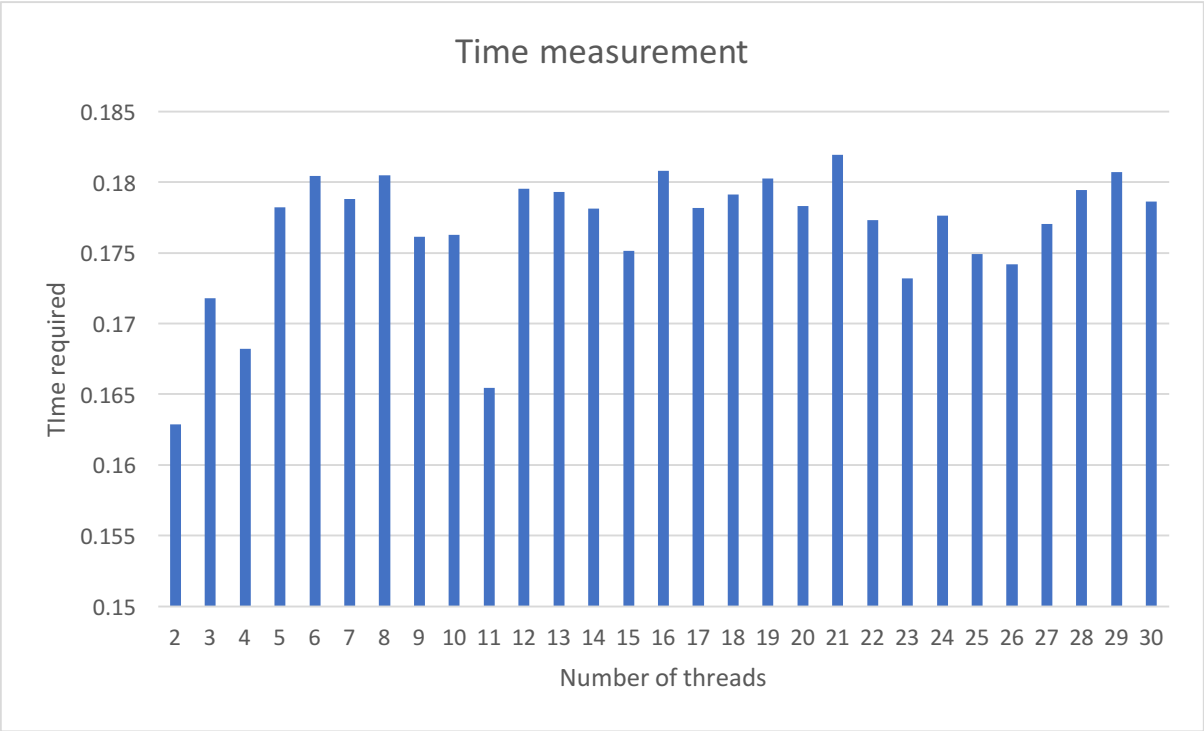
Result: In this report, I showed some results of time required for some values of N & T and if I used –nolock option or not in the table below. I calculated the required time by running the program with the same values of N & T 15 times and then took the average value of those time. The time required to complete the task is dependent on the other programs running the machine. I tested my program in the UWF CS servers measured the time from there. The time measurement was done with file writing for both stdout and stderr.

A graph of the collatz-sequence stopping time is given below for the value of 200000 as the maximum number and with 25 threads.

The time measurement graph is also given below. In that graph the number of N is fixed and the number of T varies in the x-axis. In this graph, we can see that with the increasing number of threads the time required is getting higher for some problem. So, the performance if decreasing. I addressed the problem in the README.docx file. That file is also attached with the project. But in general, the time required to complete the task using more threads should be less than using less threads to complete the task and the performance should increase.

N	T	Time required (average) s	-nolock	comment	Output
100	8	.005073	No		stdout
1000	10	.006586	No		Stdout
1000	2	.006843333	No		Stdout
1000	2	.003164667	No		File using >
1000	2	.005628333	Yes		stdout
10000	12	0.026789	no		stdout
10000	12	0.010398	yes		stdout
200000	5	0.194082	no		stdout
200000	2	0.1628688	No		File using >
200000	3	0.171777867	No		File using >
200000	4	0.1682306	no		File using >
200000	5	0.1782224	no		File using >
200000	6	0.180440733	No		File using >
200000	7	0.178814867	No		File using >
200000	8	0.180485133	No		File using >
200000	9	0.1761264	No		File using >
200000	10	0.176296533	No		File using >
200000	11	0.1654732	No		File using >
200000	12	0.179530933	No		File using >
200000	13	0.179328133	No		File using >
200000	14	0.178116333	No		File using >
200000	15	0.175129667	No		File using >
200000	16	0.180814133	No		File using >
200000	17	0.178189533	No		File using >
200000	18	0.1791328	No		File using >
200000	19	0.1802426	No		File using >
200000	20	0.178290067	No		File using >
200000	21	0.181943467	No		File using >
200000	22	0.177300267	No		File using >
200000	23	0.17319333	No		File using >
200000	24	0.1776404	No		File using >
200000	25	0.1749142	No		File using >
200000	26	0.174191867	No		File using >
200000	27	0.1770456	No		File using >
200000	28	0.1794522	No		File using >
200000	29	0.180705933	No		File using >
200000	30	0.178621533	No		File using >

Time measurement graph. This graph is calculated with the value of N 200000.

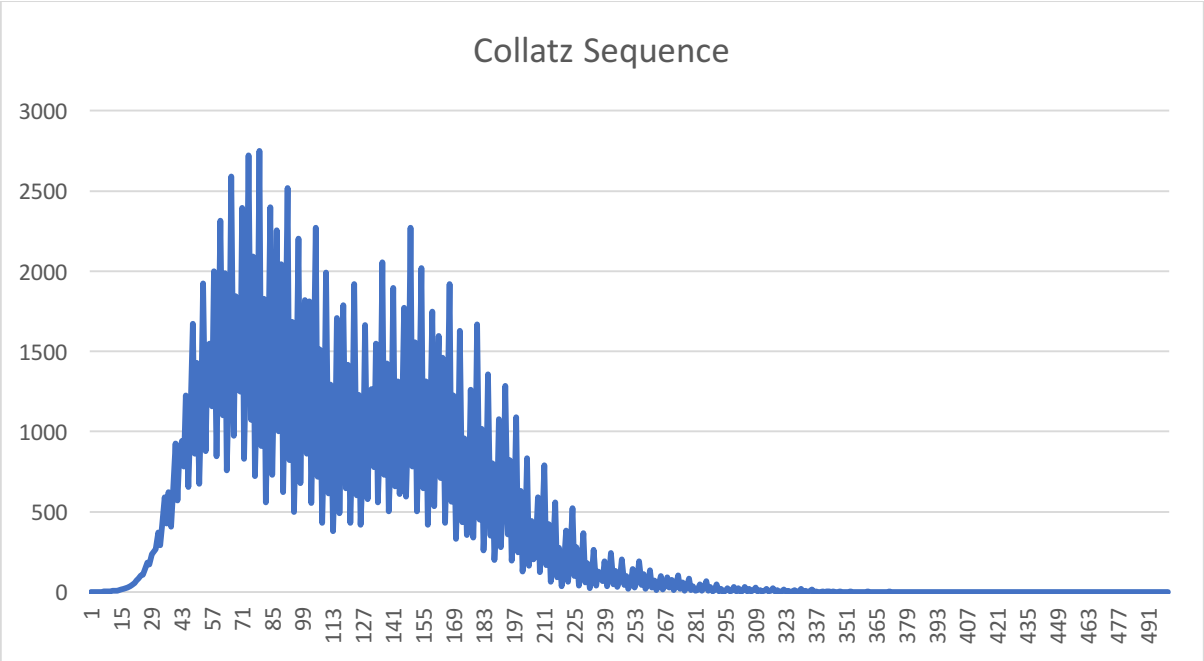


Now the table below shows some of the time required to calculate the collatz sequence using –nolock so if we use thread the calculation should create some race condition.

N	T	Time required (average) s	-nolock	comment	Output
200000	2	0.2806815	Yes		File using >
200000	3	0.269641667	Yes		File using >
200000	4	0.301185667	Yes		File using >
200000	5	0.301539067	Yes		File using >
200000	6	0.3025112	Yes		File using >
200000	7	0.304119067	Yes		File using >
200000	8	0.297914867	Yes		File using >
200000	9	0.298218533	Yes		File using >
200000	10	0.300838667	Yes		File using >
200000	11	0.2972212	Yes		File using >
200000	12	0.294405333	Yes		File using >
200000	13	0.3015412	Yes		File using >
200000	14	0.2988758	Yes		File using >
200000	15	0.306145267	Yes		File using >
200000	16	0.301616733	Yes		File using >
200000	17	0.3089822667	Yes		File using >
200000	18	0.312657533	Yes		File using >

200000	19	0.315805467	Yes		File using >
200000	20	0.308564133	Yes		File using >
200000	21	0.320376867	Yes		File using >

This is the graph of collatz sequence. I used 200000 as maximum number and I used 25 threads to calculate the stopping time of the numbers for this graph



Conclusion: calculating collatz-sequence for a number is no big deal for modern computers. That's why in this project the sequence is calculated for a big range of number and in this range, all the sequence for all the number has been calculated. This is done to get the machine bust for some certain program. To calculate the collatz-sequence for a range of large number like 100000. In this program the collatz-sequence of all number from 2 to a given number for example 100000 has been calculated. Multi-threading has been used to do this job so that the time measurement can be seen with the increase number of threads. Also, a graph of the stopping time for a collatz-sequence can be seen in above graph. When using multi-threading race condition also can be seen when lock is not using during access shared memory. The output of race condition should differ from one to another. This can be seen if output of the same program (with the same number of N & T) can be written in different files and check the difference between them.