

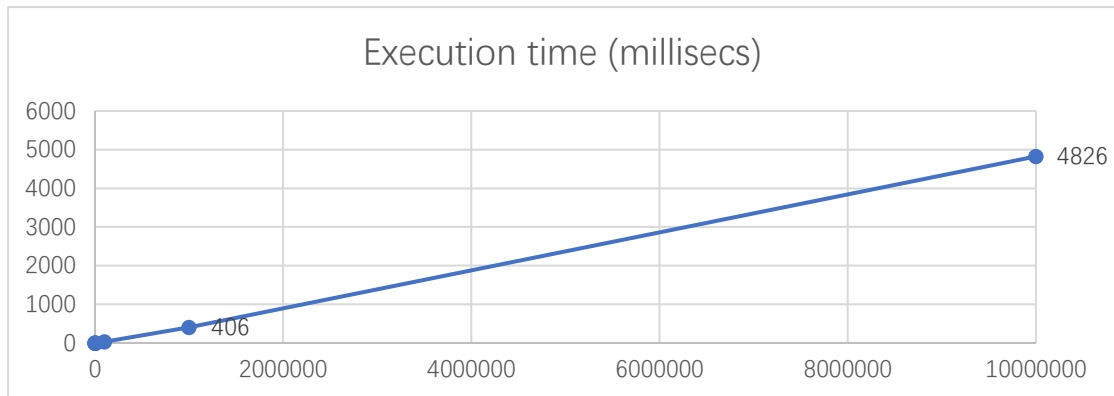
1. Prime

n	nth prime number	Execution time (milliseconds)
11	31	0
101	547	0
1001	7927	1
10001	104743	28
100001	1299721	700
1000001	15485867	19386
10000001	179424691	611267



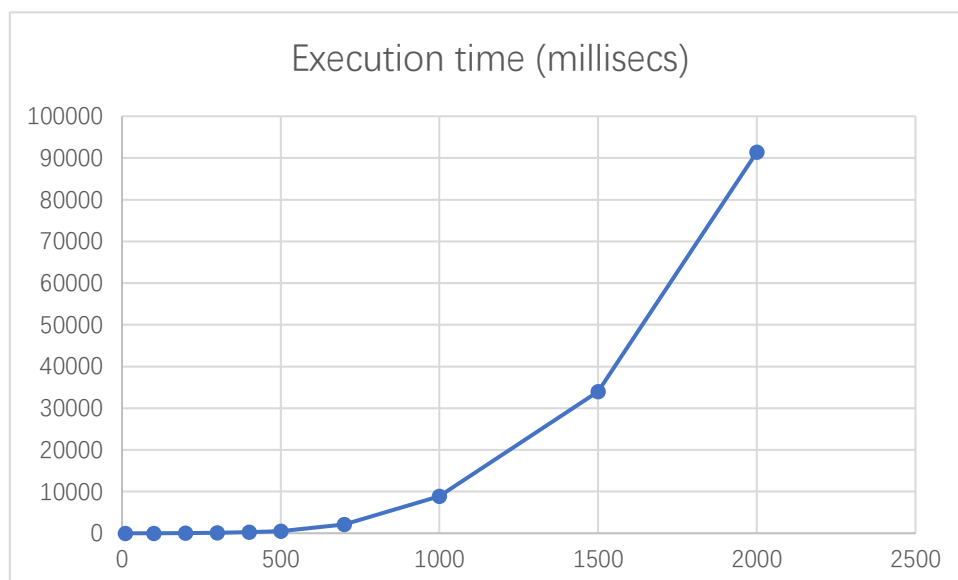
2. CollatzSequence

N	Starting Number with longest Collatz Sequence between 1 and N	Length of the longest sequence	Execution time (milliseconds)
5	3	8	0
100	97	119	0
1000	871	179	0
10000	6171	262	0
100000	77031	351	31
1000000	837799	525	406
10000000	8400511	686	4826



3. MatrixMult

Size of matrix (n)	Execution time (millisecs)
10	0
100	0
200	31
300	125
400	250
500	485
700	2140
1000	8845
1500	33977
2000	91394



4. Now try for $n = 10000$. You will notice that you get an error such as:
 Exception in thread "main" java.lang.OutOfMemoryError: Java heap space
 at MatrixMult.multiplyMatrix(MatrixMult.java:45)

at MatrixMult.main(MatrixMult.java:32)

Output :

Enter the size of each matrix: 10000

Enter the matrix element All elements of the matrices are assumed to be the same: 4

Exception in thread "main" java.lang.OutOfMemoryError: Java heap space

at MatrixMult.multiplyMatrix(MatrixMult.java:35)

at MatrixMult.main(MatrixMult.java:25)

Answer :

According to the Java Documentation, such error is caused by lack of memory.

The JAVA cannot allocate the object in the Java heap. [1]

In this case, the Matrix size is 10000 and the program would create a 2-D array with 10000 rows and 10000 columns. The memory size approximation would be

$32 + (32 + 4 * 10000) * 10000 = 400320032$ bytes. It is around 400MB. [2][3] (The way to calculate is read from those websites) It is much bigger than the default heap size.

Reference:

- [1] "Java Platform, Standard Edition Troubleshooting Guide-3.2 Understand the OutOfMemoryError Exception," *Oracle*. [Online]. Available: <https://docs.oracle.com/javase/8/docs/technotes/guides/troubleshoot/memleaks002.html>. [Accessed: 21-Sep-2018].
- [2] "How to calculate the memory usage of a Java array." [Online]. Available: https://www.javamex.com/tutorials/memory/array_memory_usage.shtml. [Accessed: 22-Sep-2018].
- [3] "how calculate java array memory usage - Stack Overflow." [Online]. Available: <https://stackoverflow.com/questions/2972578/how-calculate-java-array-memory-usage>. [Accessed: 22-Sep-2018].