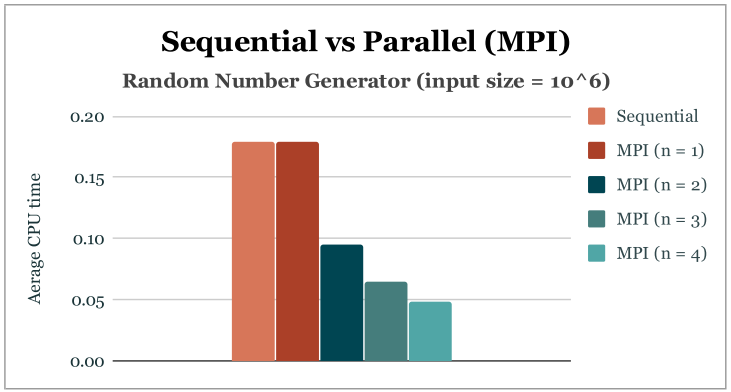
*Computer specifications are given on last page

Question 1 — Random Number Generator — input size = 10^6

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 3)	MPI (n = 4)
Attempt 1	0.178488	0.177309	0.095428	0.064593	0.046341
Attempt 2	0.181402	0.180153	0.09386	0.067904	0.047683
Attempt 3	0.175636	0.178114	0.097414	0.060462	0.050179
Average	0.1785086667	0.1785253333	0.09556733333	0.06431966667	0.04806766667

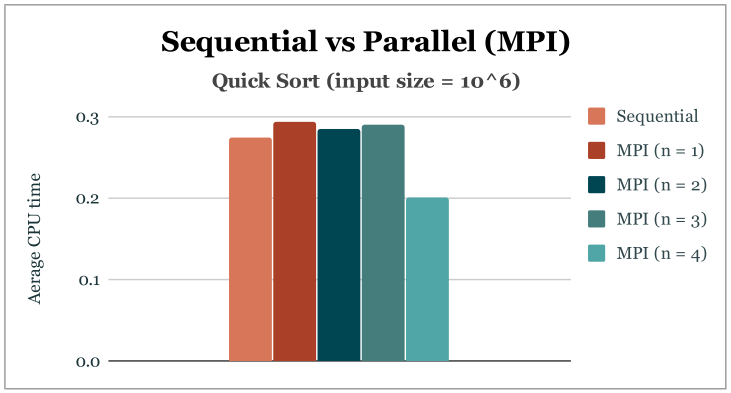
	Averge
Sequential	***0.1785086667***
MPI (n = 1)	***0.1785253333***
MPI (n = 2)	***0.0955673333***
MPI (n = 3)	***0.0643196666***
MPI (n = 4)	***0.0480676666***



Question 2 Quick Sort input size = 10^6

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 3)	MPI (n = 4)
Attempt 1	0.27051	0.282334	0.282901	0.293574	0.198997
Attempt 2	0.274016	0.296425	0.283966	0.295327	0.198871
Attempt 3	0.275765	0.297868	0.28358	0.280937	0.205222
Average	0.2734303333	0.292209	0.2834823333	0.289946	0.20103

Averge	
Sequential	***0.2734303333***
MPI (n = 1)	***0.292209***
MPI (n = 2)	***0.2834823333***
MPI (n = 3)	***0.289946***
MPI (n = 4)	***0.20103***

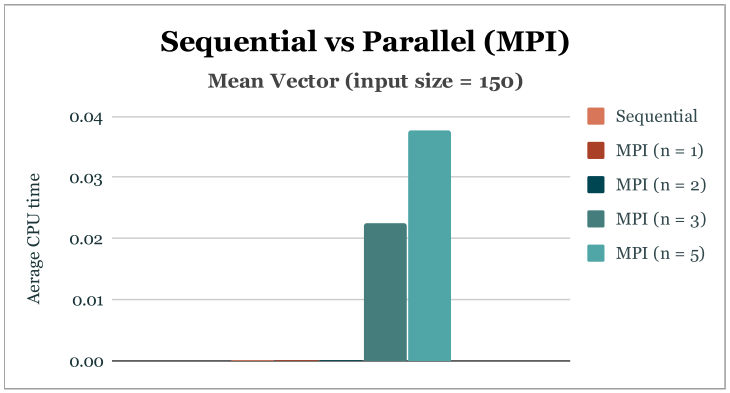


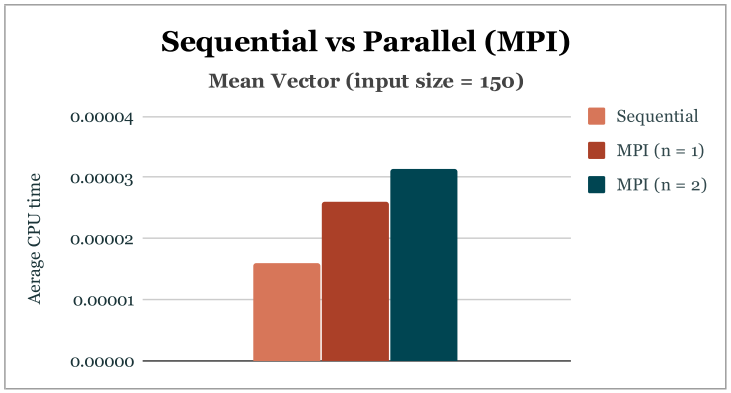
Question 3.a

Mean Vector input size = 150

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 3)	MPI (n = 5)
Attempt 1	0.000016	0.000031	0.000029	0.023826	0.048581
Attempt 2	0.000015	0.000024	0.000035	0.030124	0.037043
Attempt 3	0.000017	0.000023	0.00003	0.013227	0.027048
Average	0.000016	0.000026	0.0000313333333	0.02239233333	0.03755733333

Averge	
Sequential	***0.000016***
MPI (n = 1)	***0.000026***
MPI (n = 2)	***0.0000313333***
MPI (n = 3)	***0.0223923333***
MPI (n = 5)	***0.0375573333***



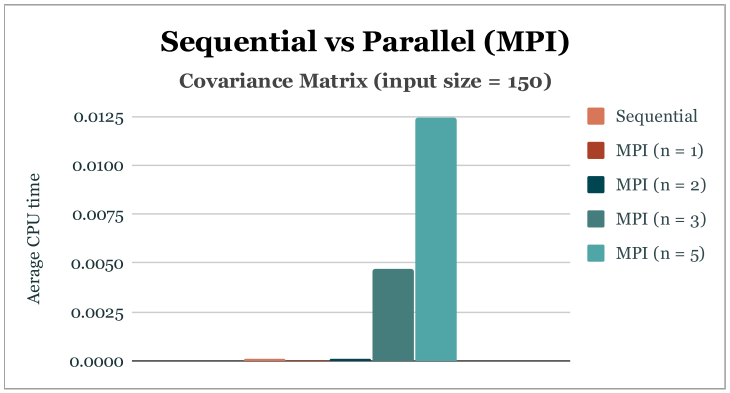


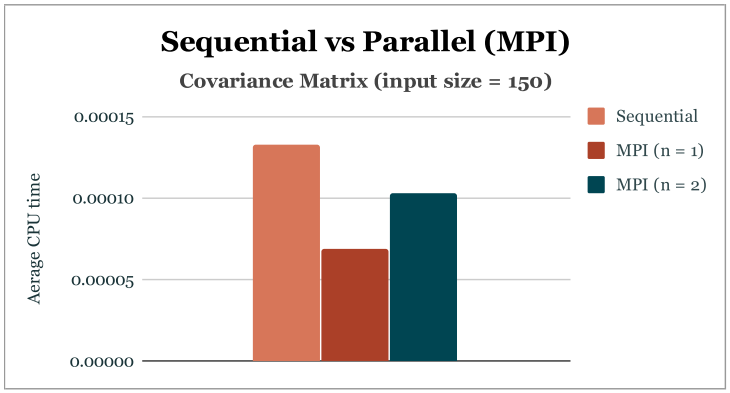
Question 3.b

Covariance Matrix input size = 150

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 3)	MPI (n = 5)
Attempt 1	0.000262	0.000074	0.000158	0.001039	0.008766
Attempt 2	0.000062	0.000082	0.000083	0.008003	0.01336
Attempt 3	0.000073	0.000049	0.000067	0.005136	0.015195
Average	0.0001323333333	0.0000683333333	0.0001026666667	0.004726	0.01244033333

Averge	
Sequential	***0.0001323333***
MPI (n = 1)	***0.0000683333***
MPI (n = 2)	***0.0001026666***
MPI (n = 3)	***0.004726***
MPI (n = 5)	***0.0124403333***



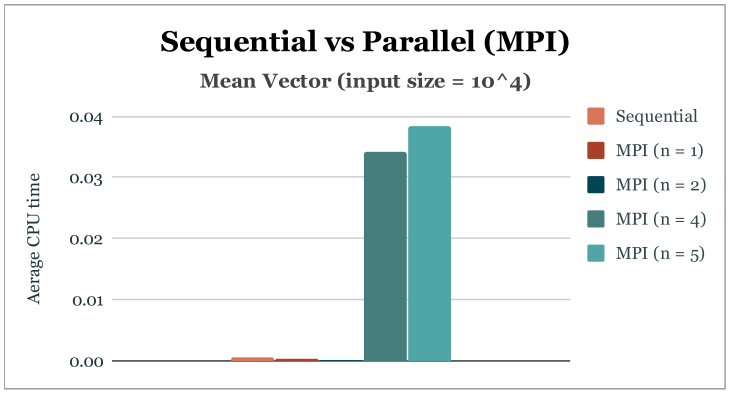


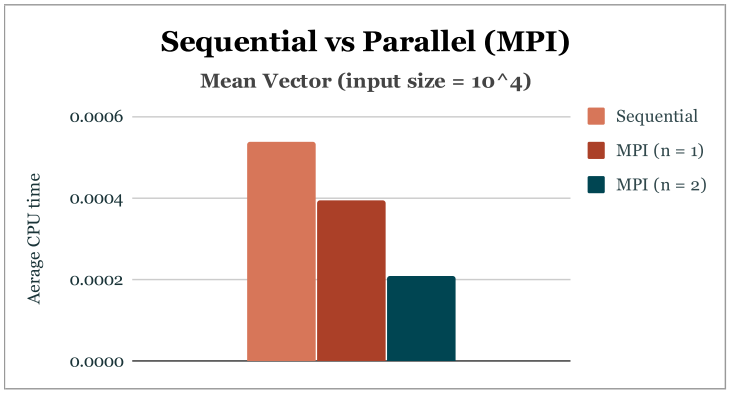
Question 3.a

Mean Vector input size = 10^4

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 4)	MPI (n = 5)
Attempt 1	0.000509	0.000394	0.000202	0.032934	0.038908
Attempt 2	0.000514	0.000396	0.00022	0.025268	0.042911
Attempt 3	0.000589	0.000387	0.000201	0.044198	0.033417
Average	0.000537333333	0.000392333333	0.000207666666	0.03413333333	0.038412

Averge	
Sequential	***0.0005373333***
MPI (n = 1)	***0.0003923333***
MPI (n = 2)	***0.0002076666***
MPI (n = 4)	***0.0341333333***
MPI (n = 5)	***0.038412***





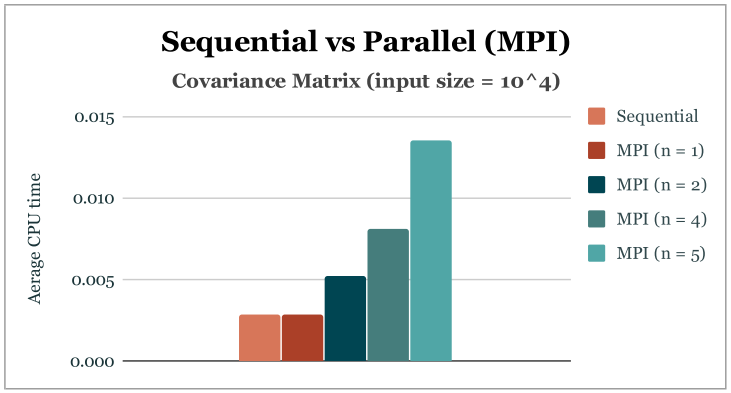
Question 3.b

Covariance Matrix

input size = 10^4

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 4)	MPI (n = 5)
Attempt 1	0.002792	0.002804	0.011857	0.005784	0.015927
Attempt 2	0.00299	0.002824	0.002153	0.009476	0.004318
Attempt 3	0.002853	0.002791	0.001482	0.008945	0.020199
Average	0.002878333333	0.002806333333	0.005164	0.008068333333	0.01348133333

Averge	
Sequential	***0.0028783333***
MPI (n = 1)	***0.0028063333***
MPI (n = 2)	***0.005164***
MPI (n = 4)	***0.0080683333***
MPI (n = 5)	***0.0134813333***

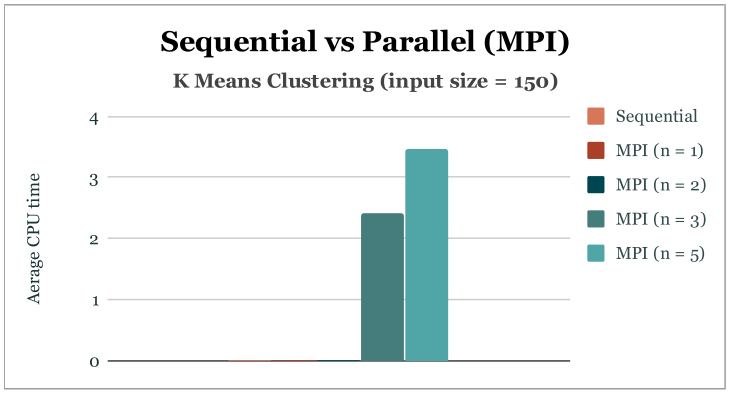


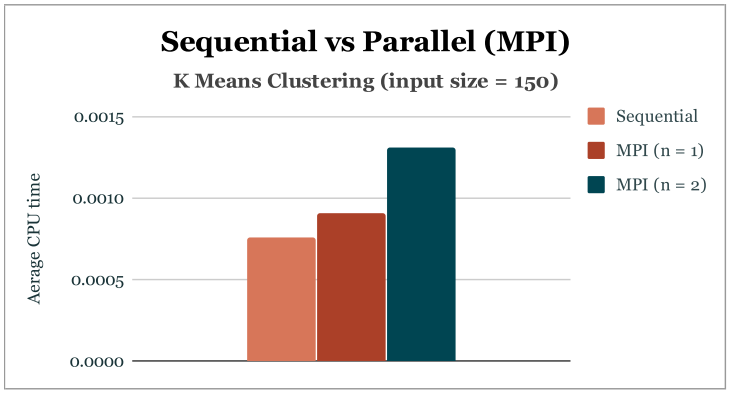
Question 4

K Means Clustering input size = 150

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 3)	MPI (n = 5)
Attempt 1	0.00082	0.000786	0.001512	2.377203	3.568567
Attempt 2	0.000563	0.000966	0.00115	2.405935	3.431168
Attempt 3	0.000892	0.000957	0.001254	2.474247	3.407221
Average	0.0007583333333	0.000903	0.001305333333	2.419128333	3.468985333

Averge	
Sequential	***0.0007583333***
MPI (n = 1)	***0.000903***
MPI (n = 2)	***0.0013053333***
MPI (n = 3)	***2.419128333***
MPI (n = 5)	***3.468985333***



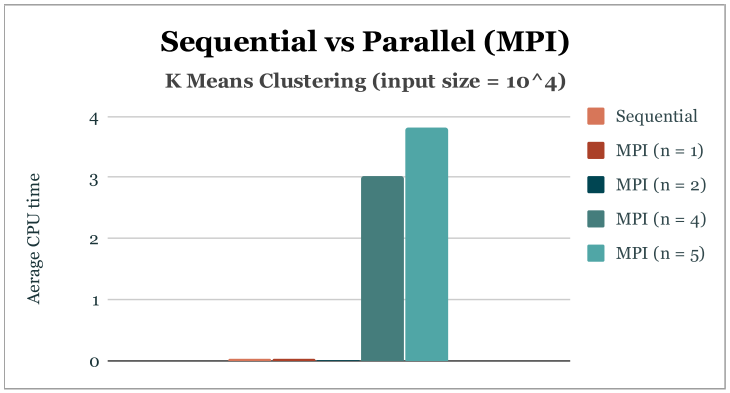


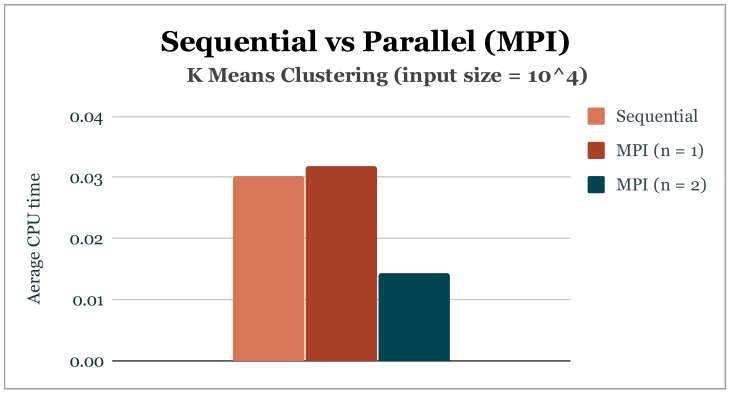
Question 4

K Means Clustering input size = 10^4

	Sequential	MPI (n = 1)	MPI (n = 2)	MPI (n = 4)	MPI (n = 5)
Attempt 1	0.030001	0.032399	0.01432	3.451951	3.76851
Attempt 2	0.030972	0.030947	0.014428	2.730011	3.818759
Attempt 3	0.029451	0.031951	0.013993	2.909189	3.859811
Average	0.03014133333	0.03176566667	0.014247	3.030383667	3.815693333

Averge	
Sequential	***0.03014133333***
MPI (n = 1)	***0.03176566667***
MPI (n = 2)	***0.014247***
MPI (n = 4)	***3.030383667***
MPI (n = 5)	***3.815693333***





Laptop Specifications

Architecture	x86_64
Memory	3.7 GiB
Byte order	Little Endian
Processor	AMD® A6-9225 radeon r4, 5 compute cores 2c+3g × 2
CPU Cores	2
Graphics	AMD® Stoney
CPU MHz	1668.688
CPU max MHz	2600
CPU min MHz	1300
L1d cache	32K
L1i cache	64K
L2 cache	1024K