Program Structures and Algorithms

Spring 2023(SEC –1)

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Task:

Your task is to implement a parallel sorting algorithm such that each partition of the array is sorted in parallel. You will consider two different schemes for deciding whether to sort in parallel.

1. A cutoff (defaults to, say, 1000) which you will update according to the first argument in the command line when running. It is your job to experiment and come up with good value for this cutoff. If there are fewer elements to sort than the cutoff, then you should use the system sort instead.
2. Recursion depth or the number of available threads. Using this determination, you might decide on an ideal number (*t*) of separate threads (stick to powers of 2) and arrange for that number of partitions to be parallelized (by preventing recursion after the depth of *lg t* is reached).
3. An appropriate combination of these.

Relationship Conclusion:

1. As per performing analysis on varied sizes of arrays for several different threads ranging from 2 to 64, we can determine that the 4 threads would be a desirable choice and using any thread beyond 4 would be waste of resources.

The following conclusion was drawn for the thread count (T) and recursion depth (d):

$T = 2^d$, lg (size of array/cutoff)

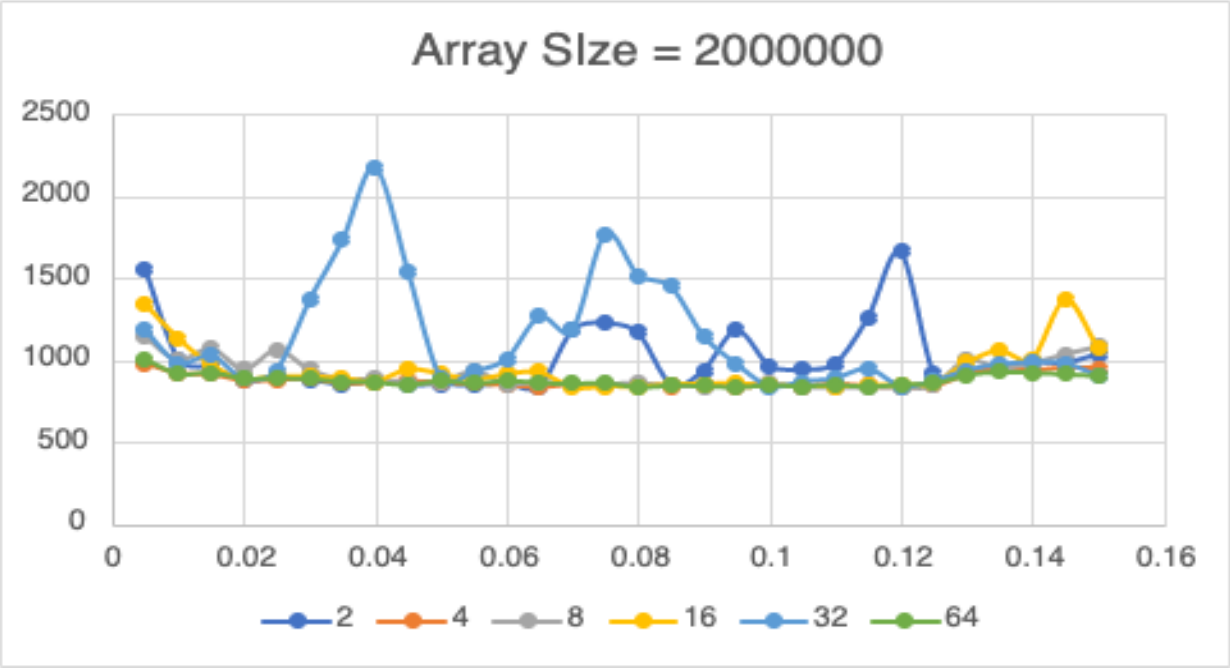
And, at any given time, the depth will not be more than maximum depth as the array reaches the cutoff.

Graphical Representation:

Array Size = 2000000

Cutoff Ratio: cutoff/size of Array

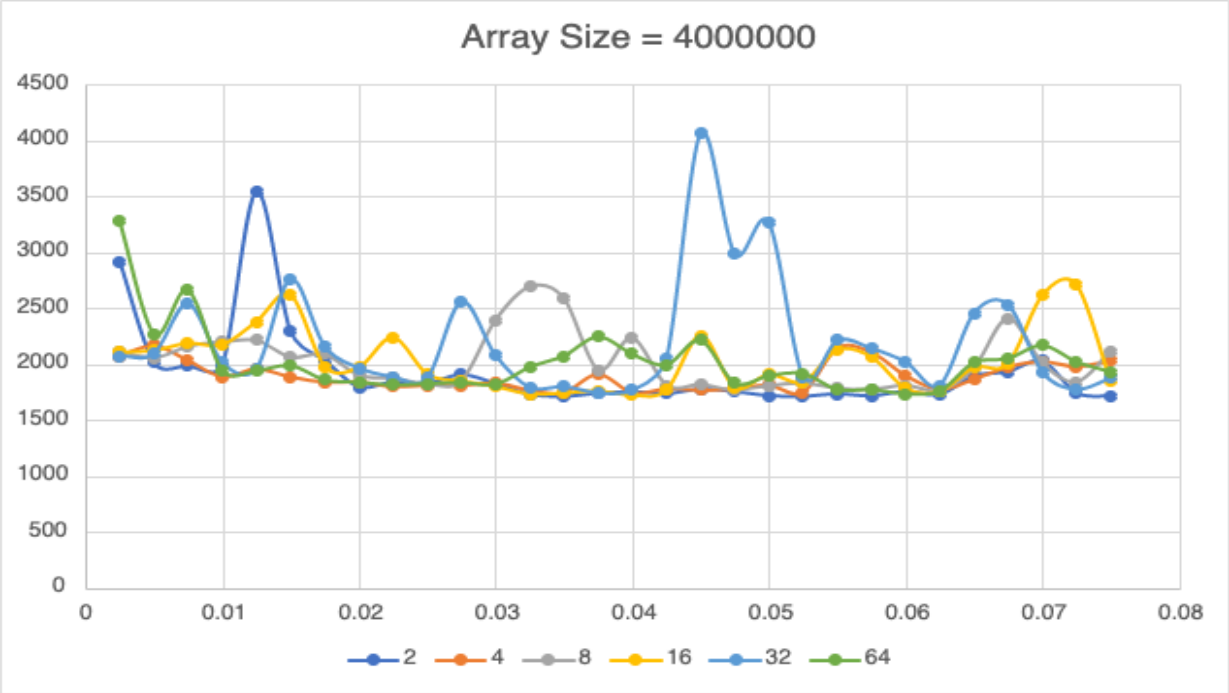
Array Size = 2000000							
cutoff	cutoff Ratio	2	4	8	16	32	64
10000	0.005	1552	981	1140	1341	1183	1005
20000	0.01	1006	919	997	1132	980	914
30000	0.015	957	914	1073	971	1030	924
40000	0.02	875	875	941	884	884	886
50000	0.025	898	879	1064	902	939	889
60000	0.03	882	890	940	898	1366	885
70000	0.035	851	857	883	891	1731	867
80000	0.04	875	865	884	869	2178	863
90000	0.045	848	873	861	945	1538	846
100000	0.05	853	863	863	916	885	873
110000	0.055	846	856	933	881	931	855
120000	0.06	857	848	853	914	1007	873
130000	0.065	838	834	867	927	1267	859
140000	0.07	1183	852	852	832	1184	855
150000	0.075	1224	844	854	840	1771	858
160000	0.08	1166	849	858	838	1518	833
170000	0.085	852	840	845	853	1449	843
180000	0.09	938	850	840	854	1144	841
190000	0.095	1185	835	846	860	976	833
200000	0.1	964	845	857	842	839	846
210000	0.105	945	840	835	846	869	839
220000	0.11	977	854	834	839	889	848
230000	0.115	1260	841	836	845	949	836
240000	0.12	1660	836	835	851	840	849
250000	0.125	919	843	841	859	872	855
260000	0.13	928	912	1003	983	939	907
270000	0.135	944	951	950	1061	974	927
280000	0.14	988	937	981	1005	988	922
290000	0.145	984	956	1035	1370	981	913
300000	0.15	1036	950	1081	1075	905	902



Array Size = 4000000

Array Size = 4000000							
cutoff	cutoff Ratio	2	4	8	16	32	64
10000	0.0025	2920	2073	2113	2106	2073	3276
20000	0.005	2012	2166	2055	2122	2093	2271
30000	0.0075	1987	2032	2158	2187	2543	2665
40000	0.01	1984	1886	2198	2174	2015	1943
50000	0.0125	3546	1958	2214	2381	1958	1941
60000	0.015	2294	1883	2062	2623	2762	1988
70000	0.0175	2035	1838	2089	1979	2158	1859
80000	0.02	1795	1841	1899	1970	1965	1837
90000	0.0225	1842	1799	1873	2242	1887	1813
100000	0.025	1827	1810	1822	1909	1873	1825
110000	0.0275	1907	1810	1852	1849	2560	1836
120000	0.03	1826	1829	2396	1800	2078	1819
130000	0.0325	1729	1765	2694	1732	1792	1973
140000	0.035	1712	1742	2589	1741	1799	2073
150000	0.0375	1739	1913	1947	1759	1743	2247
160000	0.04	1753	1741	2238	1722	1765	2089
170000	0.0425	1735	1780	1811	1767	2047	1992
180000	0.045	1778	1766	1817	2257	4068	2214
190000	0.0475	1754	1781	1769	1791	2985	1828
200000	0.05	1718	1812	1807	1909	3268	1897

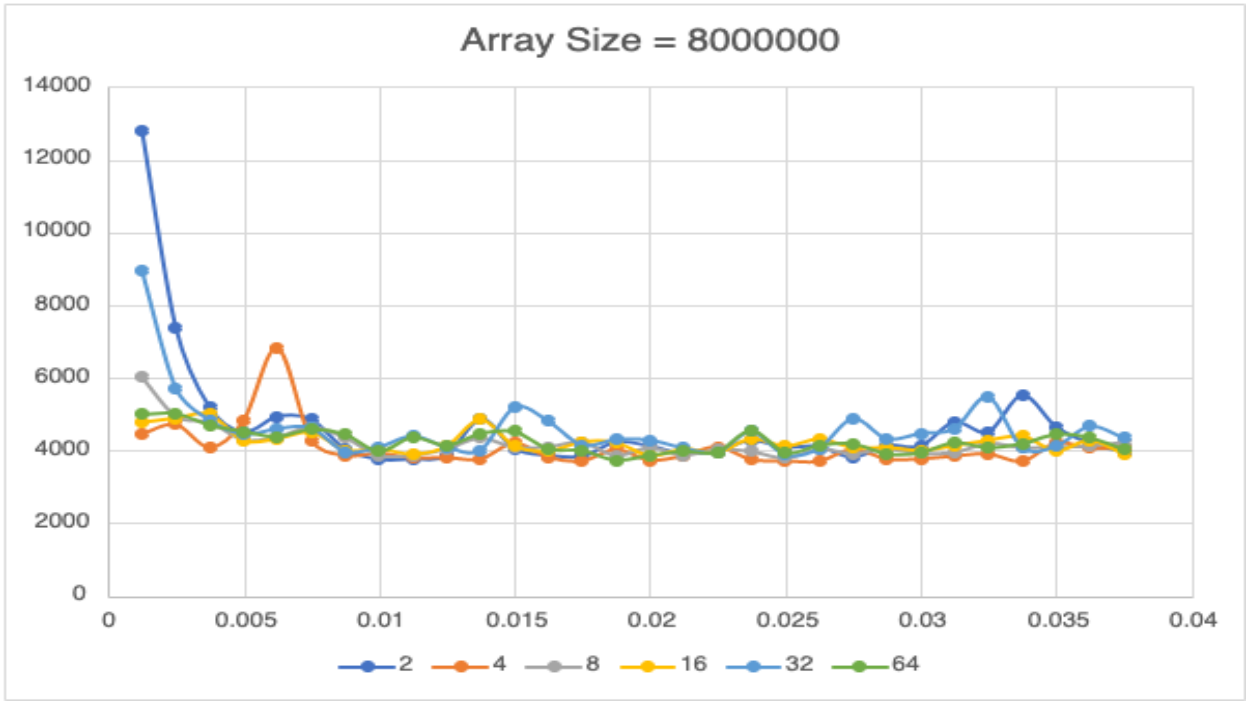
210000	0.0525	1712	1744	1831	1837	1888	1916
220000	0.055	1734	2143	1786	2128	2212	1772
230000	0.0575	1716	2106	1773	2065	2141	1772
240000	0.06	1756	1896	1811	1783	2019	1734
250000	0.0625	1729	1773	1763	1756	1810	1758
260000	0.065	1895	1865	1968	1970	2457	2014
270000	0.0675	1932	1974	2411	2005	2535	2049
280000	0.07	2028	2024	2012	2616	1930	2169
290000	0.0725	1742	1978	1841	2711	1774	2020
300000	0.075	1712	2028	2115	1850	1875	1931



Array Size = 8000000

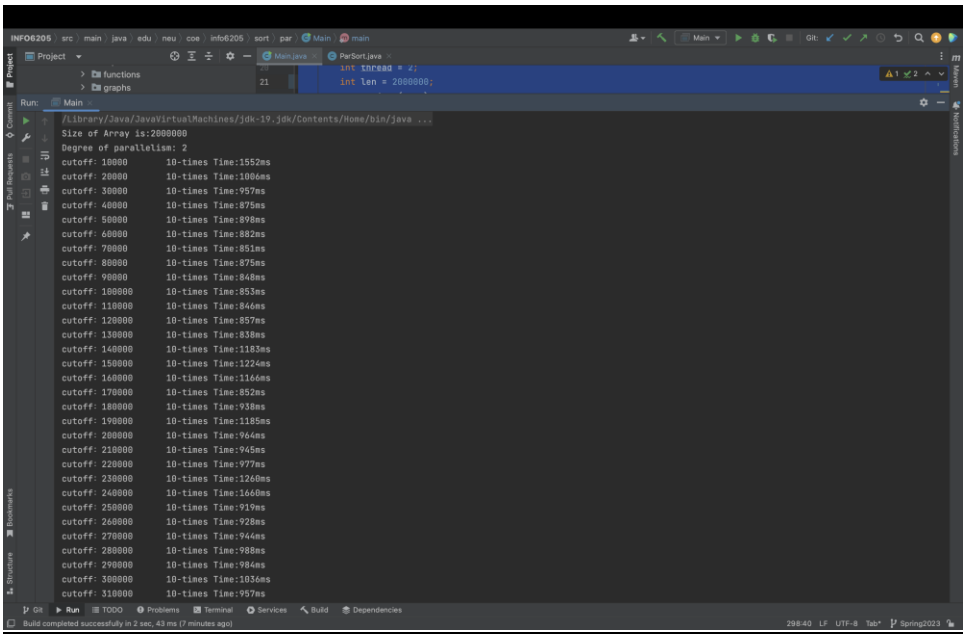
Array Size = 8000000							
cutoff	cutoff Ratio	2	4	8	16	32	64
10000	0.00125	12800	4453	6011	4776	8939	4985
20000	0.0025	7378	4718	4935	4888	5708	5014
30000	0.00375	5183	4078	4773	4993	4835	4696
40000	0.005	4505	4818	4290	4265	4444	4517
50000	0.00625	4935	6821	4365	4324	4599	4373
60000	0.0075	4856	4286	4645	4508	4621	4583
70000	0.00875	4032	3860	4351	4009	3964	4444
80000	0.01	3755	3922	3860	4042	4090	3977

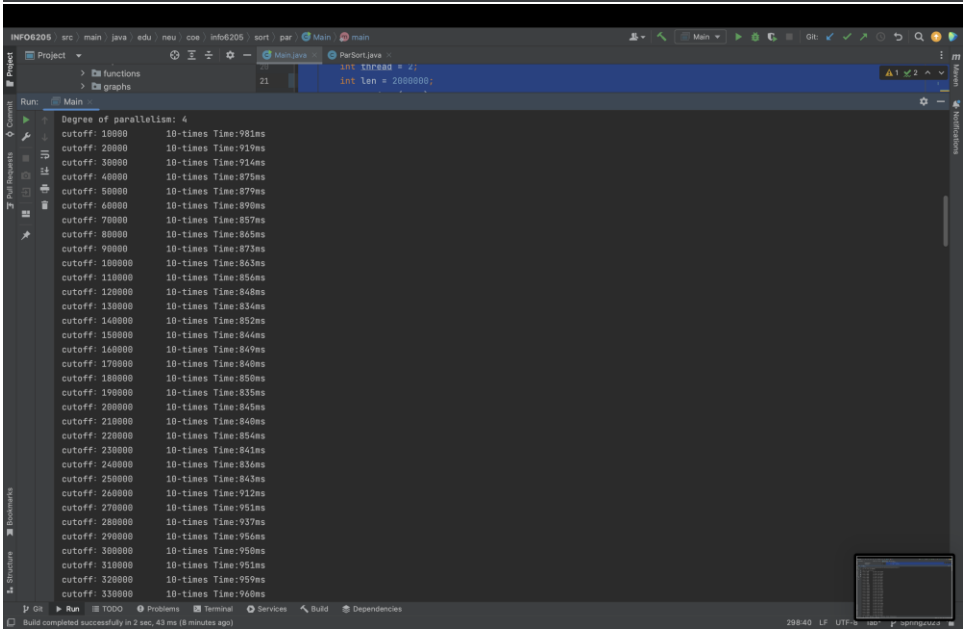
90000	0.01125	3765	3795	3863	3896	4398	4361
100000	0.0125	3848	3805	4045	4110	4085	4133
110000	0.01375	4874	3760	4338	4855	4005	4468
120000	0.015	4051	4206	4081	4122	5183	4522
130000	0.01625	3866	3812	4095	3981	4808	4036
140000	0.0175	3836	3707	4226	4232	4137	3998
150000	0.01875	4228	4029	3854	4215	4301	3733
160000	0.02	4125	3728	4077	3848	4283	3860
170000	0.02125	3919	3858	3869	4040	4064	3978
180000	0.0225	4000	4102	4028	3946	3952	3951
190000	0.02375	4273	3746	3970	4326	4522	4560
200000	0.025	4084	3716	3785	4110	3874	3932
210000	0.02625	4112	3699	4030	4313	4056	4136
220000	0.0275	3807	4041	3916	4078	4884	4180
230000	0.02875	4143	3759	4036	4084	4315	3907
240000	0.03	4121	3770	3920	4001	4470	3932
250000	0.03125	4787	3845	3940	4136	4596	4222
260000	0.0325	4498	3908	4196	4279	5478	4069
270000	0.03375	5525	3697	4076	4402	4073	4181
280000	0.035	4648	4212	4094	3991	4117	4440
290000	0.03625	4197	4064	4117	4279	4666	4350
300000	0.0375	3961	4084	4225	3900	4345	4027

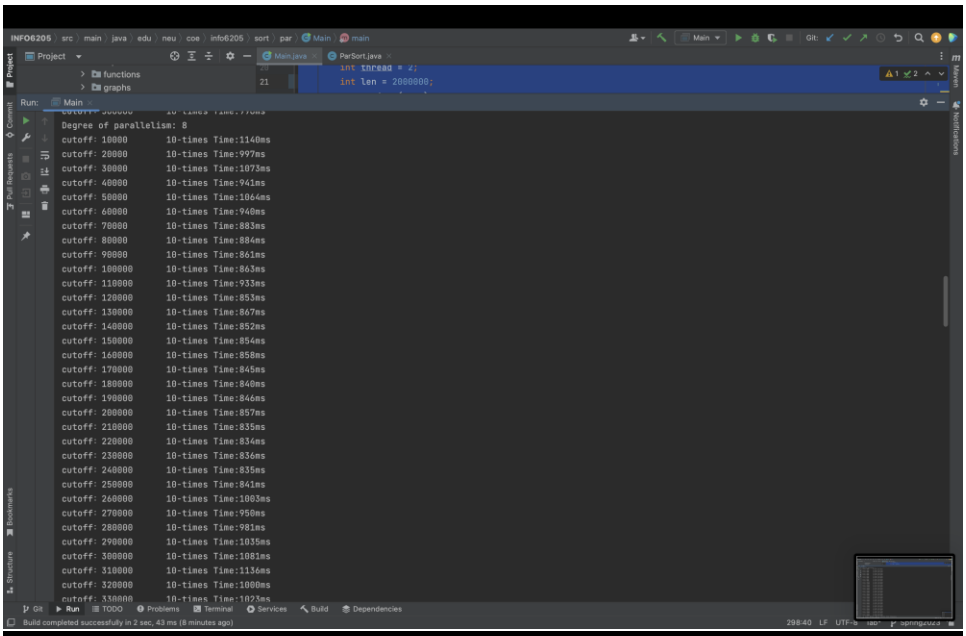


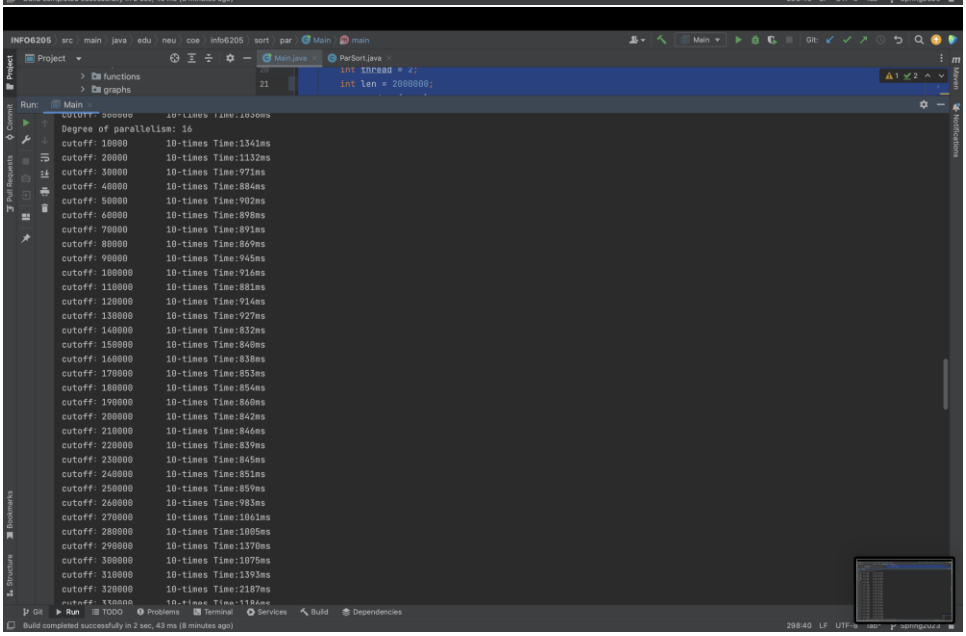
Evidence to support Conclusion:

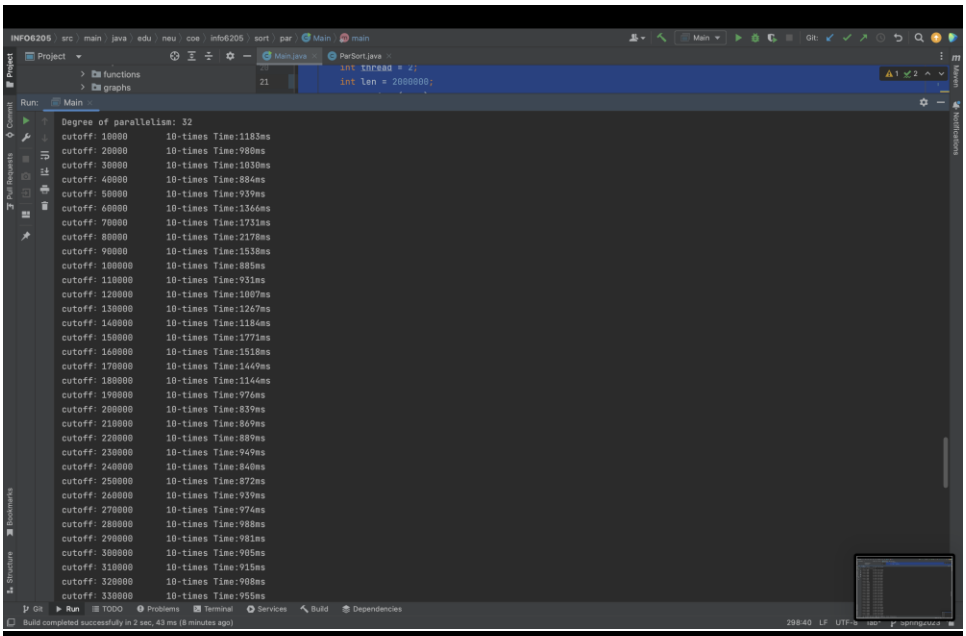
<u>Array Size = 2000000</u>

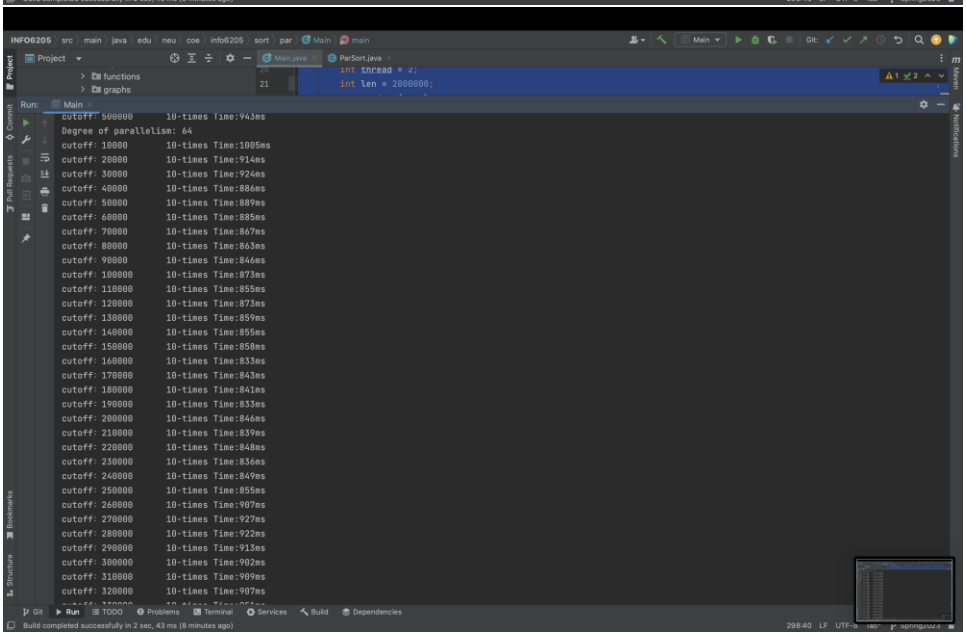




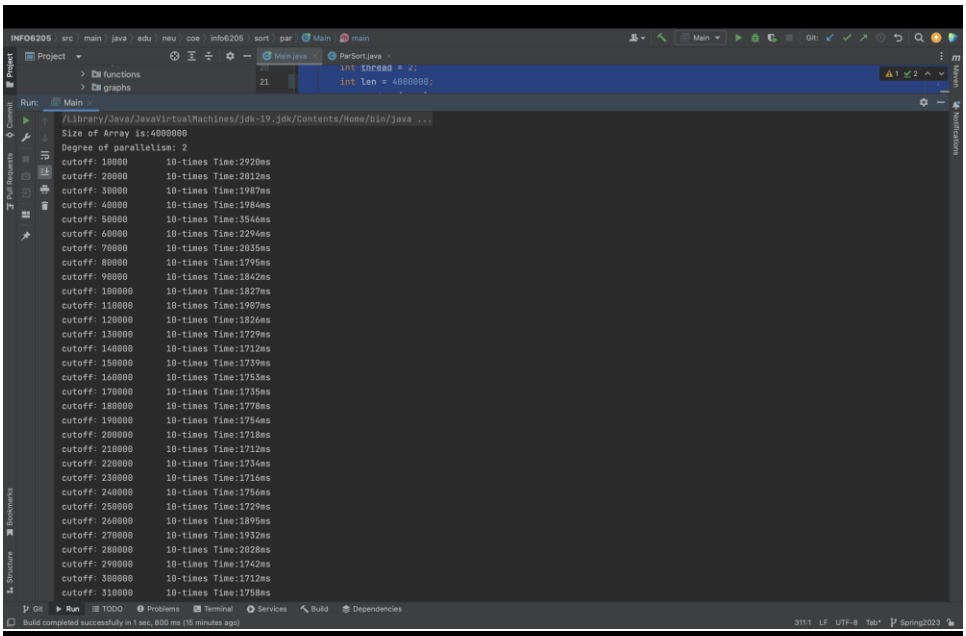

int nread = 4;
int len = 2000000;
Degree of parallelism: 8
cutoff: 10000 10-times Time:1140ms
cutoff: 20000 10-times Time:997ms
cutoff: 30000 10-times Time:1073ms
cutoff: 40000 10-times Time:941ms
cutoff: 50000 10-times Time:1064ms
cutoff: 60000 10-times Time:940ms
cutoff: 70000 10-times Time:883ms
cutoff: 80000 10-times Time:884ms
cutoff: 90000 10-times Time:861ms
cutoff: 100000 10-times Time:863ms
cutoff: 110000 10-times Time:933ms
cutoff: 120000 10-times Time:853ms
cutoff: 130000 10-times Time:867ms
cutoff: 140000 10-times Time:852ms
cutoff: 150000 10-times Time:854ms
cutoff: 160000 10-times Time:858ms
cutoff: 170000 10-times Time:845ms
cutoff: 180000 10-times Time:840ms
cutoff: 190000 10-times Time:846ms
cutoff: 200000 10-times Time:857ms
cutoff: 210000 10-times Time:835ms
cutoff: 220000 10-times Time:834ms
cutoff: 230000 10-times Time:836ms
cutoff: 240000 10-times Time:835ms
cutoff: 250000 10-times Time:841ms
cutoff: 260000 10-times Time:1003ms
cutoff: 270000 10-times Time:950ms
cutoff: 280000 10-times Time:981ms
cutoff: 290000 10-times Time:1035ms
cutoff: 300000 10-times Time:1081ms
cutoff: 310000 10-times Time:1136ms
cutoff: 320000 10-times Time:1000ms

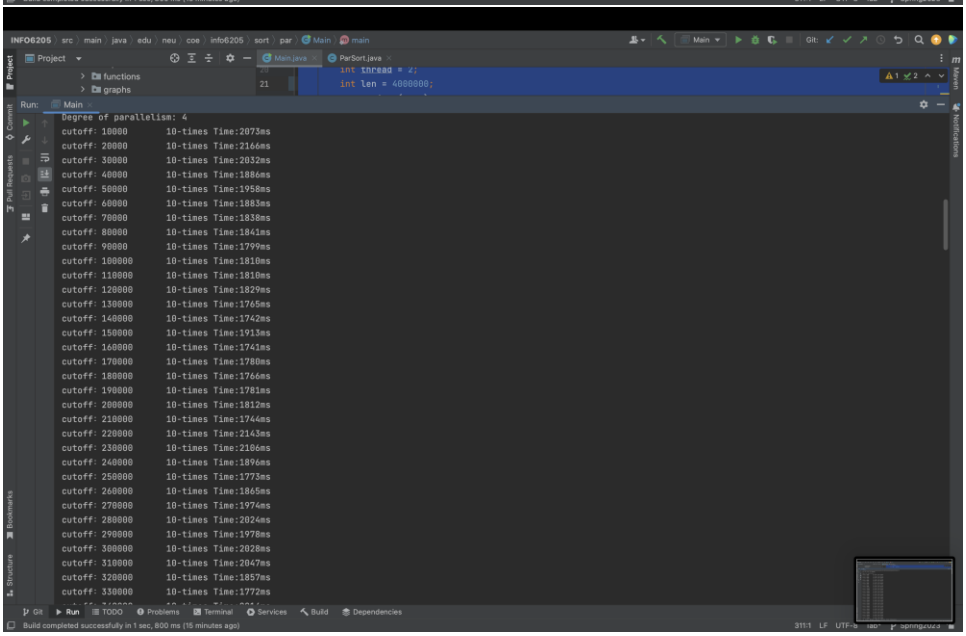

int nread = 4;
int len = 2000000;
Degree of parallelism: 16
cutoff: 10000 10-times Time:1341ms
cutoff: 20000 10-times Time:1132ms
cutoff: 30000 10-times Time:971ms
cutoff: 40000 10-times Time:884ms
cutoff: 50000 10-times Time:902ms
cutoff: 60000 10-times Time:898ms
cutoff: 70000 10-times Time:891ms
cutoff: 80000 10-times Time:869ms
cutoff: 90000 10-times Time:945ms
cutoff: 100000 10-times Time:916ms
cutoff: 110000 10-times Time:881ms
cutoff: 120000 10-times Time:914ms
cutoff: 130000 10-times Time:927ms
cutoff: 140000 10-times Time:832ms
cutoff: 150000 10-times Time:840ms
cutoff: 160000 10-times Time:838ms
cutoff: 170000 10-times Time:853ms
cutoff: 180000 10-times Time:854ms
cutoff: 190000 10-times Time:860ms
cutoff: 200000 10-times Time:842ms
cutoff: 210000 10-times Time:846ms
cutoff: 220000 10-times Time:839ms
cutoff: 230000 10-times Time:845ms
cutoff: 240000 10-times Time:851ms
cutoff: 250000 10-times Time:859ms
cutoff: 260000 10-times Time:983ms
cutoff: 270000 10-times Time:1061ms
cutoff: 280000 10-times Time:1005ms
cutoff: 290000 10-times Time:1370ms
cutoff: 300000 10-times Time:1075ms
cutoff: 310000 10-times Time:1393ms
cutoff: 320000 10-times Time:2187ms

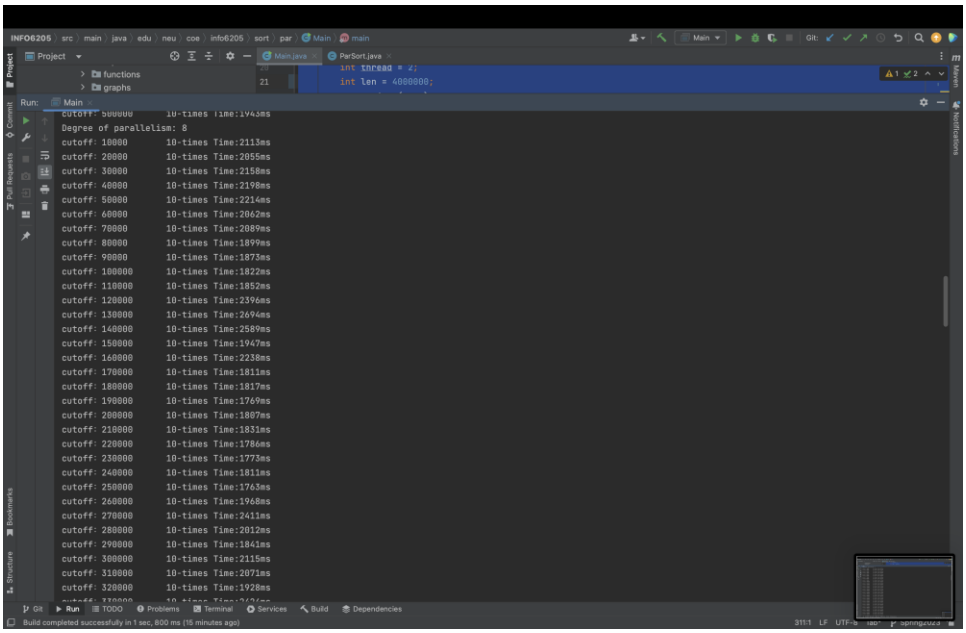


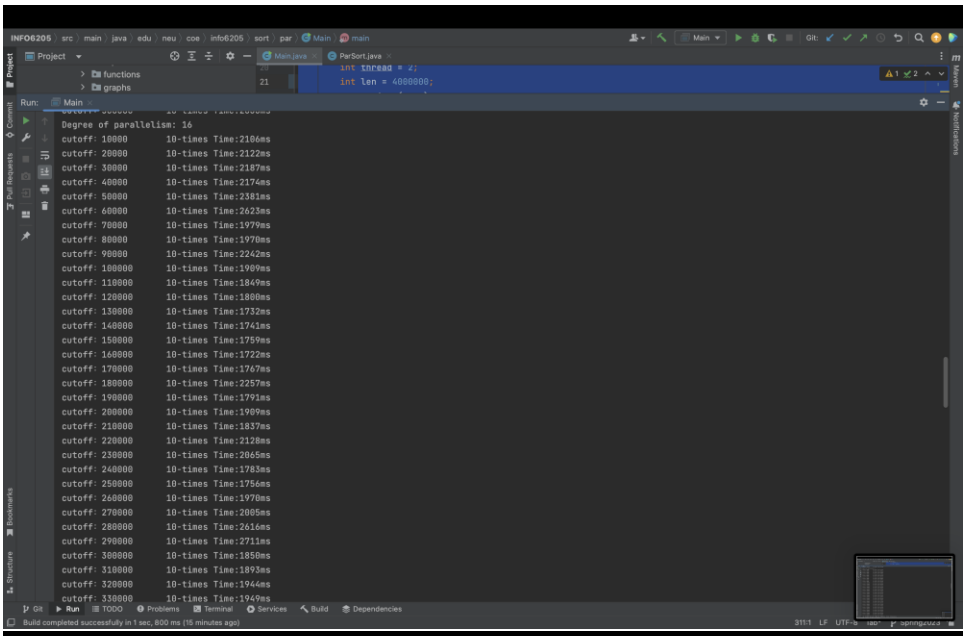


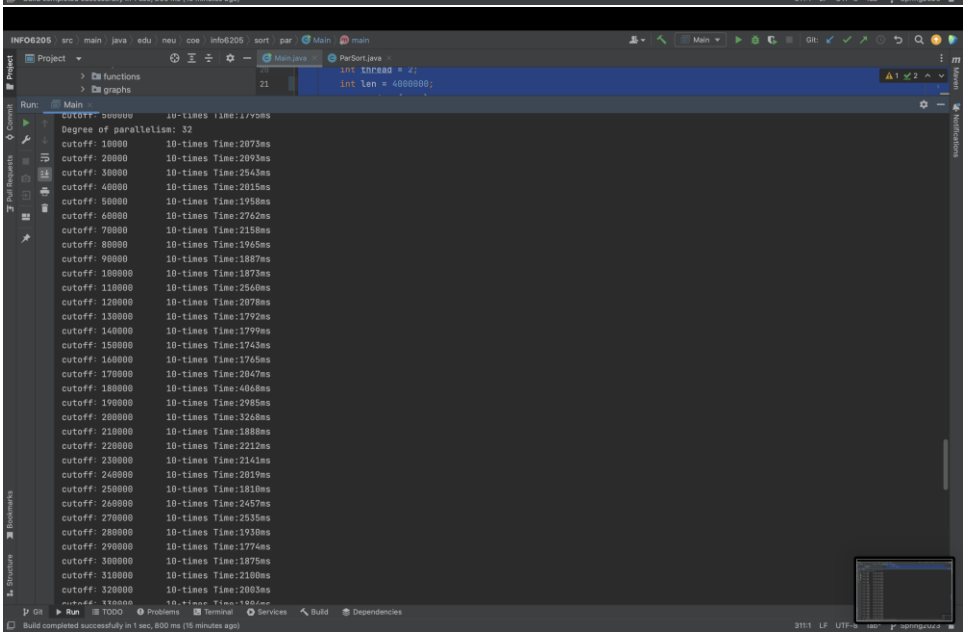
Array Size = 4000000

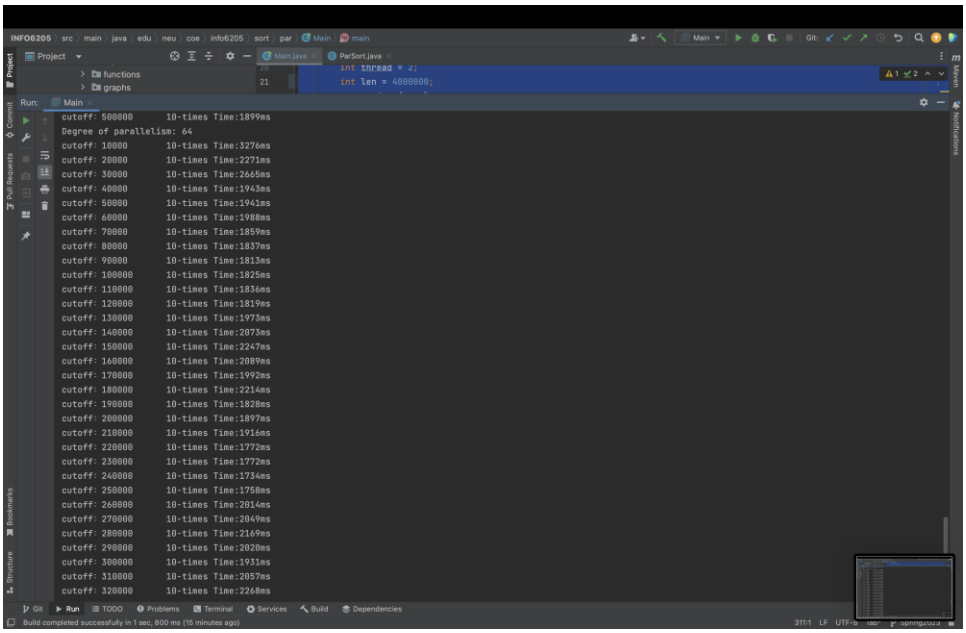

int nthread = 2;
int len = 4000000;
/Library/Java/JavaVirtualMachines/jdk-19.jdk/Contents/Home/bin/java ...
Size of Array is:4000000
Degree of parallelism: 2
cutoff: 10000 10-times Time:2920ms
cutoff: 20000 10-times Time:2012ms
cutoff: 30000 10-times Time:1987ms
cutoff: 40000 10-times Time:1984ms
cutoff: 50000 10-times Time:3546ms
cutoff: 60000 10-times Time:2294ms
cutoff: 70000 10-times Time:2035ms
cutoff: 80000 10-times Time:1795ms
cutoff: 90000 10-times Time:1842ms
cutoff: 100000 10-times Time:1827ms
cutoff: 110000 10-times Time:1907ms
cutoff: 120000 10-times Time:1826ms
cutoff: 130000 10-times Time:1729ms
cutoff: 140000 10-times Time:1712ms
cutoff: 150000 10-times Time:1739ms
cutoff: 160000 10-times Time:1753ms
cutoff: 170000 10-times Time:1735ms
cutoff: 180000 10-times Time:1778ms
cutoff: 190000 10-times Time:1754ms
cutoff: 200000 10-times Time:1718ms
cutoff: 210000 10-times Time:1712ms
cutoff: 220000 10-times Time:1734ms
cutoff: 230000 10-times Time:1716ms
cutoff: 240000 10-times Time:1756ms
cutoff: 250000 10-times Time:1729ms
cutoff: 260000 10-times Time:1895ms
cutoff: 270000 10-times Time:1932ms
cutoff: 280000 10-times Time:2028ms
cutoff: 290000 10-times Time:1742ms
cutoff: 300000 10-times Time:1712ms
cutoff: 310000 10-times Time:1758ms


int nthread = 4;
int len = 4000000;
Degree of parallelism: 4
cutoff: 10000 10-times Time:2073ms
cutoff: 20000 10-times Time:2166ms
cutoff: 30000 10-times Time:2032ms
cutoff: 40000 10-times Time:1886ms
cutoff: 50000 10-times Time:1958ms
cutoff: 60000 10-times Time:1883ms
cutoff: 70000 10-times Time:1838ms
cutoff: 80000 10-times Time:1841ms
cutoff: 90000 10-times Time:1799ms
cutoff: 100000 10-times Time:1810ms
cutoff: 110000 10-times Time:1810ms
cutoff: 120000 10-times Time:1829ms
cutoff: 130000 10-times Time:1765ms
cutoff: 140000 10-times Time:1742ms
cutoff: 150000 10-times Time:1913ms
cutoff: 160000 10-times Time:1741ms
cutoff: 170000 10-times Time:1780ms
cutoff: 180000 10-times Time:1766ms
cutoff: 190000 10-times Time:1781ms
cutoff: 200000 10-times Time:1812ms
cutoff: 210000 10-times Time:1744ms
cutoff: 220000 10-times Time:2143ms
cutoff: 230000 10-times Time:2106ms
cutoff: 240000 10-times Time:1896ms
cutoff: 250000 10-times Time:1773ms
cutoff: 260000 10-times Time:1865ms
cutoff: 270000 10-times Time:1974ms
cutoff: 280000 10-times Time:2024ms
cutoff: 290000 10-times Time:1978ms
cutoff: 300000 10-times Time:2028ms
cutoff: 310000 10-times Time:2047ms
cutoff: 320000 10-times Time:1857ms
cutoff: 330000 10-times Time:1772ms

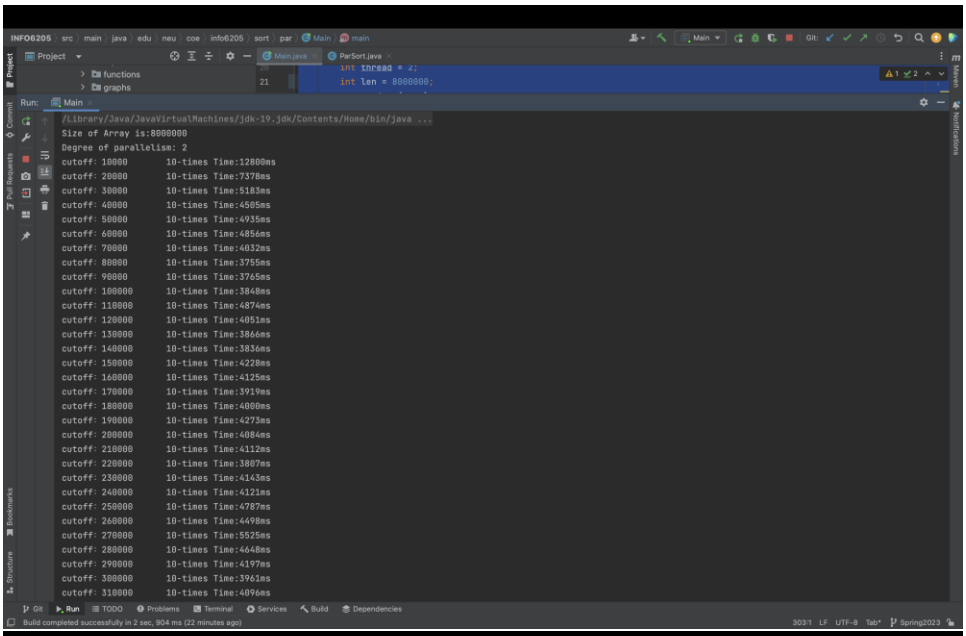

int nread = 4;
int len = 4000000;
Run: Main
Degree of parallelism: 8
cutoff: 10000 10-times Time:2113ms
cutoff: 20000 10-times Time:2055ms
cutoff: 30000 10-times Time:2158ms
cutoff: 40000 10-times Time:2198ms
cutoff: 50000 10-times Time:2214ms
cutoff: 60000 10-times Time:2062ms
cutoff: 70000 10-times Time:2089ms
cutoff: 80000 10-times Time:1899ms
cutoff: 90000 10-times Time:1873ms
cutoff: 100000 10-times Time:1822ms
cutoff: 110000 10-times Time:1852ms
cutoff: 120000 10-times Time:2396ms
cutoff: 130000 10-times Time:2694ms
cutoff: 140000 10-times Time:2589ms
cutoff: 150000 10-times Time:1947ms
cutoff: 160000 10-times Time:2238ms
cutoff: 170000 10-times Time:1811ms
cutoff: 180000 10-times Time:1817ms
cutoff: 190000 10-times Time:1769ms
cutoff: 200000 10-times Time:1807ms
cutoff: 210000 10-times Time:1831ms
cutoff: 220000 10-times Time:1786ms
cutoff: 230000 10-times Time:1773ms
cutoff: 240000 10-times Time:1811ms
cutoff: 250000 10-times Time:1763ms
cutoff: 260000 10-times Time:1968ms
cutoff: 270000 10-times Time:2411ms
cutoff: 280000 10-times Time:2012ms
cutoff: 290000 10-times Time:1841ms
cutoff: 300000 10-times Time:2115ms
cutoff: 310000 10-times Time:2071ms
cutoff: 320000 10-times Time:1928ms

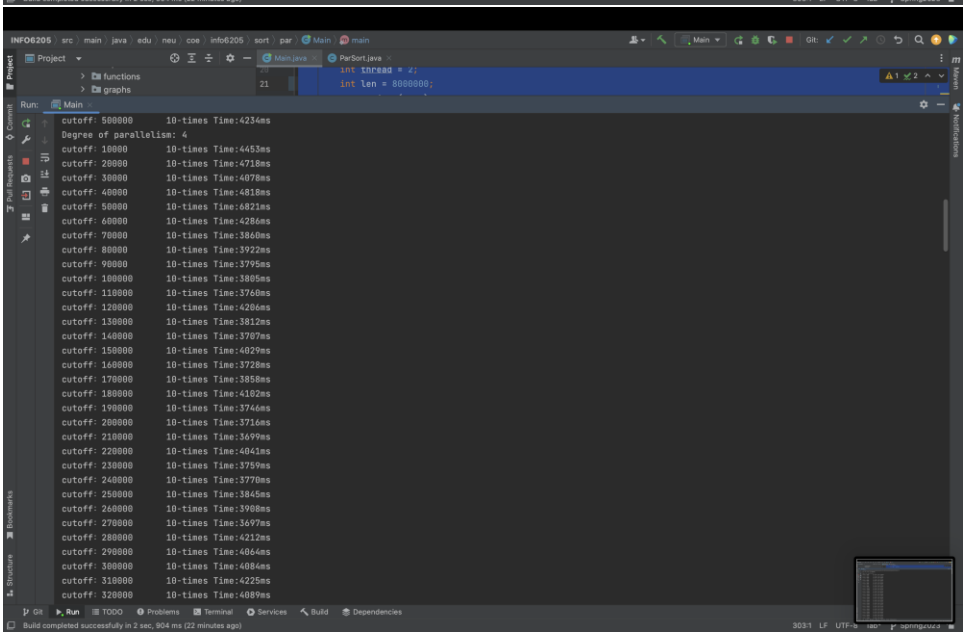

Degree of parallelism: 16
cutoff: 10000 10-times Time:2106ms
cutoff: 20000 10-times Time:2122ms
cutoff: 30000 10-times Time:2187ms
cutoff: 40000 10-times Time:2174ms
cutoff: 50000 10-times Time:2381ms
cutoff: 60000 10-times Time:2623ms
cutoff: 70000 10-times Time:1979ms
cutoff: 80000 10-times Time:1970ms
cutoff: 90000 10-times Time:2242ms
cutoff: 100000 10-times Time:1909ms
cutoff: 110000 10-times Time:1849ms
cutoff: 120000 10-times Time:1800ms
cutoff: 130000 10-times Time:1732ms
cutoff: 140000 10-times Time:1741ms
cutoff: 150000 10-times Time:1759ms
cutoff: 160000 10-times Time:1722ms
cutoff: 170000 10-times Time:1767ms
cutoff: 180000 10-times Time:2257ms
cutoff: 190000 10-times Time:1791ms
cutoff: 200000 10-times Time:1909ms
cutoff: 210000 10-times Time:1837ms
cutoff: 220000 10-times Time:2128ms
cutoff: 230000 10-times Time:2065ms
cutoff: 240000 10-times Time:1783ms
cutoff: 250000 10-times Time:1756ms
cutoff: 260000 10-times Time:1970ms
cutoff: 270000 10-times Time:2005ms
cutoff: 280000 10-times Time:2616ms
cutoff: 290000 10-times Time:2711ms
cutoff: 300000 10-times Time:1858ms
cutoff: 310000 10-times Time:1893ms
cutoff: 320000 10-times Time:1944ms
cutoff: 330000 10-times Time:1949ms

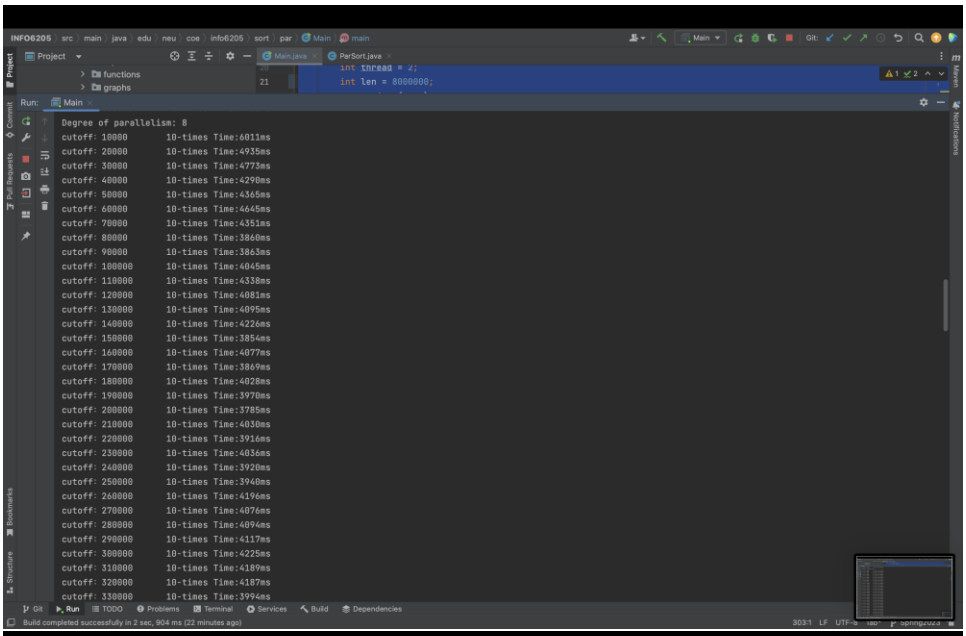

Degree of parallelism: 32
cutoff: 10000 10-times Time:2073ms
cutoff: 20000 10-times Time:2093ms
cutoff: 30000 10-times Time:2543ms
cutoff: 40000 10-times Time:2015ms
cutoff: 50000 10-times Time:1958ms
cutoff: 60000 10-times Time:2762ms
cutoff: 70000 10-times Time:2158ms
cutoff: 80000 10-times Time:1965ms
cutoff: 90000 10-times Time:1887ms
cutoff: 100000 10-times Time:1873ms
cutoff: 110000 10-times Time:2560ms
cutoff: 120000 10-times Time:2078ms
cutoff: 130000 10-times Time:1792ms
cutoff: 140000 10-times Time:1799ms
cutoff: 150000 10-times Time:1743ms
cutoff: 160000 10-times Time:1765ms
cutoff: 170000 10-times Time:2047ms
cutoff: 180000 10-times Time:4068ms
cutoff: 190000 10-times Time:2985ms
cutoff: 200000 10-times Time:3268ms
cutoff: 210000 10-times Time:1888ms
cutoff: 220000 10-times Time:2212ms
cutoff: 230000 10-times Time:2141ms
cutoff: 240000 10-times Time:2019ms
cutoff: 250000 10-times Time:1810ms
cutoff: 260000 10-times Time:2457ms
cutoff: 270000 10-times Time:2535ms
cutoff: 280000 10-times Time:1930ms
cutoff: 290000 10-times Time:1774ms
cutoff: 300000 10-times Time:1875ms
cutoff: 310000 10-times Time:2100ms
cutoff: 320000 10-times Time:2003ms

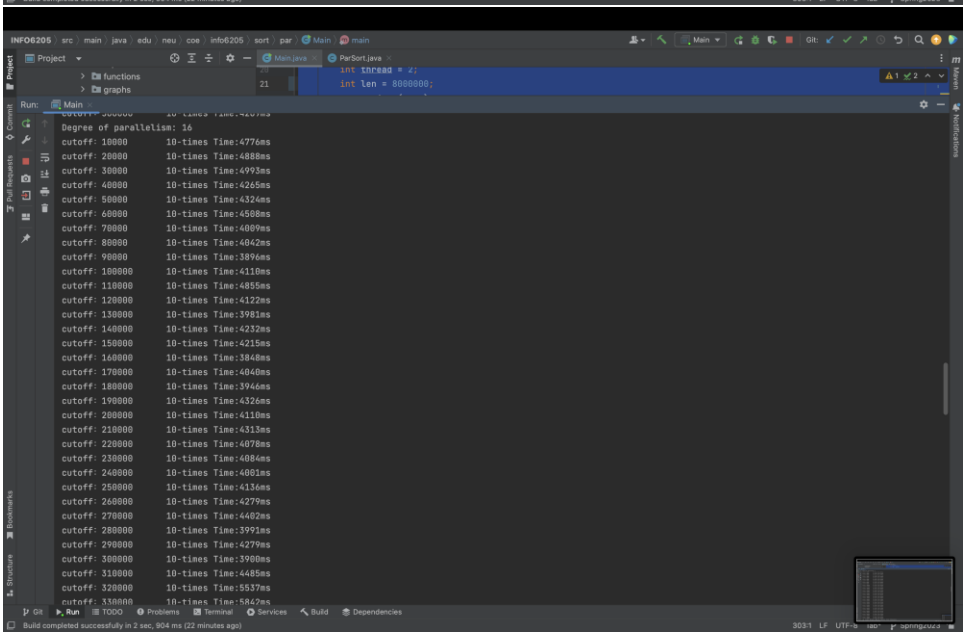


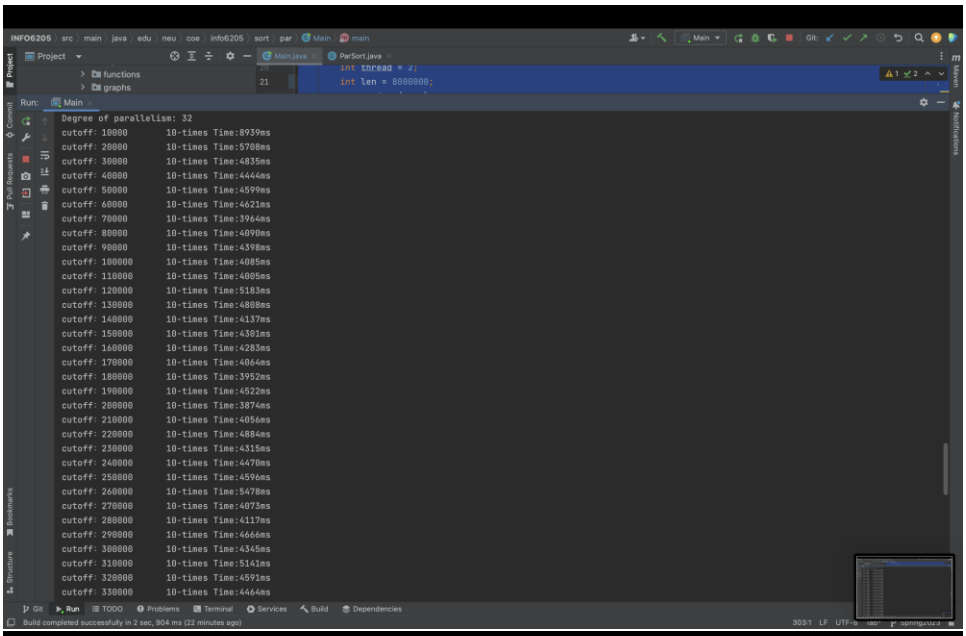
Array Size = 8000000

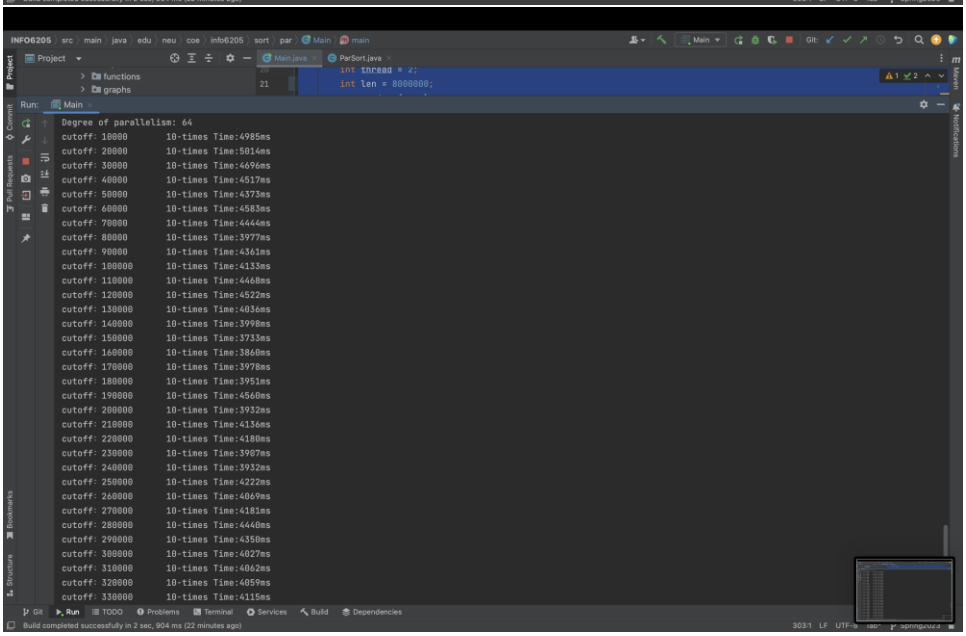

/Library/Java/JavaVirtualMachines/jdk-19.jdk/Contents/Home/bin/java ...
Size of Array is:8000000
Degree of parallelism: 2
cutoff: 10000 10-times Time:12800ms
cutoff: 20000 10-times Time:7378ms
cutoff: 30000 10-times Time:5183ms
cutoff: 40000 10-times Time:4505ms
cutoff: 50000 10-times Time:4935ms
cutoff: 60000 10-times Time:4856ms
cutoff: 70000 10-times Time:4032ms
cutoff: 80000 10-times Time:3755ms
cutoff: 90000 10-times Time:3765ms
cutoff: 100000 10-times Time:3848ms
cutoff: 110000 10-times Time:4874ms
cutoff: 120000 10-times Time:4051ms
cutoff: 130000 10-times Time:3866ms
cutoff: 140000 10-times Time:3836ms
cutoff: 150000 10-times Time:4228ms
cutoff: 160000 10-times Time:4125ms
cutoff: 170000 10-times Time:3919ms
cutoff: 180000 10-times Time:4000ms
cutoff: 190000 10-times Time:4273ms
cutoff: 200000 10-times Time:4084ms
cutoff: 210000 10-times Time:4112ms
cutoff: 220000 10-times Time:3807ms
cutoff: 230000 10-times Time:4143ms
cutoff: 240000 10-times Time:4121ms
cutoff: 250000 10-times Time:4787ms
cutoff: 260000 10-times Time:4498ms
cutoff: 270000 10-times Time:5525ms
cutoff: 280000 10-times Time:4648ms
cutoff: 290000 10-times Time:4197ms
cutoff: 300000 10-times Time:3961ms
cutoff: 310000 10-times Time:4096ms


cutoff: 500000 10-times Time:4234ms
Degree of parallelism: 4
cutoff: 10000 10-times Time:4453ms
cutoff: 20000 10-times Time:4718ms
cutoff: 30000 10-times Time:4078ms
cutoff: 40000 10-times Time:4818ms
cutoff: 50000 10-times Time:6821ms
cutoff: 60000 10-times Time:4286ms
cutoff: 70000 10-times Time:3860ms
cutoff: 80000 10-times Time:3922ms
cutoff: 90000 10-times Time:3795ms
cutoff: 100000 10-times Time:3805ms
cutoff: 110000 10-times Time:3760ms
cutoff: 120000 10-times Time:4206ms
cutoff: 130000 10-times Time:3812ms
cutoff: 140000 10-times Time:3707ms
cutoff: 150000 10-times Time:4029ms
cutoff: 160000 10-times Time:3728ms
cutoff: 170000 10-times Time:3858ms
cutoff: 180000 10-times Time:4102ms
cutoff: 190000 10-times Time:3746ms
cutoff: 200000 10-times Time:3716ms
cutoff: 210000 10-times Time:3699ms
cutoff: 220000 10-times Time:4041ms
cutoff: 230000 10-times Time:3759ms
cutoff: 240000 10-times Time:3770ms
cutoff: 250000 10-times Time:3845ms
cutoff: 260000 10-times Time:3908ms
cutoff: 270000 10-times Time:3697ms
cutoff: 280000 10-times Time:4212ms
cutoff: 290000 10-times Time:4064ms
cutoff: 300000 10-times Time:4084ms
cutoff: 310000 10-times Time:4225ms
cutoff: 320000 10-times Time:4089ms


int inread = 2;
int len = 8000000;
Degree of parallelism: 8
cutoff: 10000 10-times Time:6011ms
cutoff: 20000 10-times Time:4935ms
cutoff: 30000 10-times Time:4773ms
cutoff: 40000 10-times Time:4290ms
cutoff: 50000 10-times Time:4365ms
cutoff: 60000 10-times Time:4645ms
cutoff: 70000 10-times Time:4351ms
cutoff: 80000 10-times Time:3860ms
cutoff: 90000 10-times Time:3863ms
cutoff: 100000 10-times Time:4045ms
cutoff: 110000 10-times Time:4338ms
cutoff: 120000 10-times Time:4081ms
cutoff: 130000 10-times Time:4095ms
cutoff: 140000 10-times Time:4226ms
cutoff: 150000 10-times Time:3854ms
cutoff: 160000 10-times Time:4077ms
cutoff: 170000 10-times Time:3869ms
cutoff: 180000 10-times Time:4028ms
cutoff: 190000 10-times Time:3970ms
cutoff: 200000 10-times Time:3785ms
cutoff: 210000 10-times Time:4030ms
cutoff: 220000 10-times Time:3916ms
cutoff: 230000 10-times Time:4036ms
cutoff: 240000 10-times Time:3920ms
cutoff: 250000 10-times Time:3940ms
cutoff: 260000 10-times Time:4196ms
cutoff: 270000 10-times Time:4076ms
cutoff: 280000 10-times Time:4094ms
cutoff: 290000 10-times Time:4117ms
cutoff: 300000 10-times Time:4225ms
cutoff: 310000 10-times Time:4189ms
cutoff: 320000 10-times Time:4187ms
cutoff: 330000 10-times Time:3994ms


int inread = 2;
int len = 8000000;
Degree of parallelism: 16
cutoff: 10000 10-times Time:4776ms
cutoff: 20000 10-times Time:4888ms
cutoff: 30000 10-times Time:4993ms
cutoff: 40000 10-times Time:4265ms
cutoff: 50000 10-times Time:4324ms
cutoff: 60000 10-times Time:4508ms
cutoff: 70000 10-times Time:4009ms
cutoff: 80000 10-times Time:4042ms
cutoff: 90000 10-times Time:3896ms
cutoff: 100000 10-times Time:4110ms
cutoff: 110000 10-times Time:4855ms
cutoff: 120000 10-times Time:4122ms
cutoff: 130000 10-times Time:3981ms
cutoff: 140000 10-times Time:4232ms
cutoff: 150000 10-times Time:4215ms
cutoff: 160000 10-times Time:3848ms
cutoff: 170000 10-times Time:4040ms
cutoff: 180000 10-times Time:3946ms
cutoff: 190000 10-times Time:4326ms
cutoff: 200000 10-times Time:4110ms
cutoff: 210000 10-times Time:4313ms
cutoff: 220000 10-times Time:4078ms
cutoff: 230000 10-times Time:4084ms
cutoff: 240000 10-times Time:4001ms
cutoff: 250000 10-times Time:4136ms
cutoff: 260000 10-times Time:4279ms
cutoff: 270000 10-times Time:4402ms
cutoff: 280000 10-times Time:3991ms
cutoff: 290000 10-times Time:4279ms
cutoff: 300000 10-times Time:3900ms
cutoff: 310000 10-times Time:4485ms
cutoff: 320000 10-times Time:5537ms


int nread = 4;
int len = 8000000;
Run: Main
Degree of parallelism: 32
cutoff: 10000 10-times Time:8939ms
cutoff: 20000 10-times Time:5708ms
cutoff: 30000 10-times Time:4835ms
cutoff: 40000 10-times Time:4444ms
cutoff: 50000 10-times Time:4599ms
cutoff: 60000 10-times Time:4621ms
cutoff: 70000 10-times Time:3964ms
cutoff: 80000 10-times Time:4090ms
cutoff: 90000 10-times Time:4398ms
cutoff: 100000 10-times Time:4085ms
cutoff: 110000 10-times Time:4005ms
cutoff: 120000 10-times Time:5183ms
cutoff: 130000 10-times Time:4808ms
cutoff: 140000 10-times Time:4137ms
cutoff: 150000 10-times Time:4301ms
cutoff: 160000 10-times Time:4283ms
cutoff: 170000 10-times Time:4064ms
cutoff: 180000 10-times Time:3952ms
cutoff: 190000 10-times Time:4522ms
cutoff: 200000 10-times Time:3874ms
cutoff: 210000 10-times Time:4056ms
cutoff: 220000 10-times Time:4884ms
cutoff: 230000 10-times Time:4315ms
cutoff: 240000 10-times Time:4470ms
cutoff: 250000 10-times Time:4596ms
cutoff: 260000 10-times Time:5478ms
cutoff: 270000 10-times Time:4073ms
cutoff: 280000 10-times Time:4117ms
cutoff: 290000 10-times Time:4666ms
cutoff: 300000 10-times Time:4345ms
cutoff: 310000 10-times Time:5141ms
cutoff: 320000 10-times Time:4591ms
cutoff: 330000 10-times Time:4464ms
Build completed successfully in 2 sec, 904 ms (22 minutes ago)


int nread = 4;
int len = 8000000;
Run: Main
Degree of parallelism: 64
cutoff: 10000 10-times Time:4985ms
cutoff: 20000 10-times Time:5014ms
cutoff: 30000 10-times Time:4696ms
cutoff: 40000 10-times Time:4517ms
cutoff: 50000 10-times Time:4373ms
cutoff: 60000 10-times Time:4583ms
cutoff: 70000 10-times Time:4444ms
cutoff: 80000 10-times Time:3977ms
cutoff: 90000 10-times Time:4361ms
cutoff: 100000 10-times Time:4133ms
cutoff: 110000 10-times Time:4468ms
cutoff: 120000 10-times Time:4522ms
cutoff: 130000 10-times Time:4036ms
cutoff: 140000 10-times Time:3998ms
cutoff: 150000 10-times Time:3733ms
cutoff: 160000 10-times Time:3860ms
cutoff: 170000 10-times Time:3978ms
cutoff: 180000 10-times Time:3951ms
cutoff: 190000 10-times Time:4560ms
cutoff: 200000 10-times Time:3932ms
cutoff: 210000 10-times Time:4136ms
cutoff: 220000 10-times Time:4180ms
cutoff: 230000 10-times Time:3907ms
cutoff: 240000 10-times Time:3932ms
cutoff: 250000 10-times Time:4222ms
cutoff: 260000 10-times Time:4069ms
cutoff: 270000 10-times Time:4181ms
cutoff: 280000 10-times Time:4440ms
cutoff: 290000 10-times Time:4350ms
cutoff: 300000 10-times Time:4027ms
cutoff: 310000 10-times Time:4062ms
cutoff: 320000 10-times Time:4059ms
cutoff: 330000 10-times Time:4115ms
Build completed successfully in 2 sec, 904 ms (22 minutes ago)