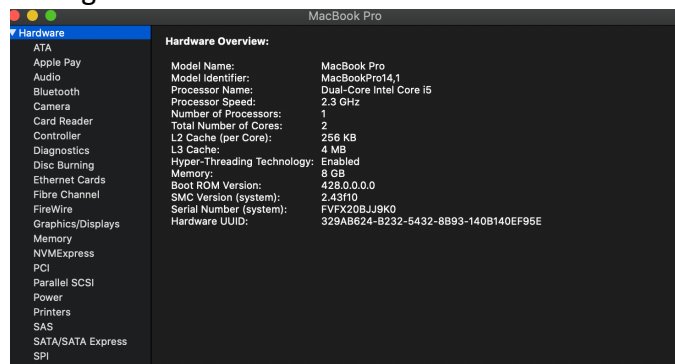


I first wrote a sequential algorithm to find the second minimum number in an array. When doubling the size of the array these are the time it took for the algorithm to solve the problem.

N	Time (NS)	Ratio
50	8231664	N/A
100	383428	.46
200	823658	2.15
400	941654	1.15
800	408808	4.34
1600	450100	1.10
3200	527055	1.12
6400	701694	1.33
12800	941894	1.34
25600	1573408	1.67
51200	2884713	1.833
102400	2399674	.83
204800	8494596	3.54
409600	930032	1.09
819200	1778090	1.9
1638400	5888261	3.3
3276800	7777950	1.3
6553600	6677271	.85
13107200	14409287	2.1
26214400	31048679	2.1

As we double it the ratio between the time it took to run an input of n and $2n$, with some outliers, approaches 2. Therefore, the Algorithm is $O(n)$ time.

I then wrote an algorithm using fork join in order to decrease the amount of time it took to run the algorithm.



I have 2 cores on my computer

When putting it through the doubling test with a threshold of 0.7 of the original array size, this was the speed difference between fork join and sequential.

N	Fj time (NS)	Sequential time (NS)	ratio
n =50	6283652	3413	0
n =100	325291	4921	0
n =200	348530	9812	0
n =400	281204	19836	0
n =800	315323	38026	0
n =1600	271195	51459	0
n =3200	427818	140655	0
n =6400	431068	261618	0
n =12800	1683766	605104	0
n =25600	1517593	1088641	0
n =51200	1866786	499072	0
n =102400	2812242	1033389	0
n =204800	3844031	13893780	3.6
n =409600	7782224	4480930	0
n =819200	16097804	6950302	0
n =1638400	3503289	7127066	2.03
n =3276800	6284140	12712059	2.02
n =6553600	11671327	18092092	1.55
n =13107200	13866834	26806403	1.93
n =26214400	39722383	90393213	2.27
n =52428800	37662476	94026124	2.49

With the threshold at .3 of the array size

n =50	fj time15082219	sequential time4404	speed up = 2.9199947302184113E-4
n =100	fj time431212	sequential time5206	speed up = 0.012072947877146276
n =200	fj time340579	sequential time8809	speed up = 0.025864777335067635
n =400	fj time347665	sequential time20102	speed up = 0.05782002790042138
n =800	fj time935070	sequential time40548	speed up = 0.04336359844717508
n =1600	fj time696917	sequential time77091	speed up = 0.11061718970838708
n =3200	fj time2241633	sequential time117995	speed up = 0.05263796526906947
n =6400	fj time670753	sequential time267826	speed up = 0.3992915424903057

n =12800	fj time1485159	sequential time1963664	speed up = 1.3221910919975572
n =25600	fj time2585738	sequential time1319452	speed up = 0.5102806239456589
n =51200	fj time2361985	sequential time5000989	speed up = 2.1172822858739577
n =102400	fj time8692561	sequential time1124753	speed up = 0.12939259212561177
n =204800	fj time3871659	sequential time2124229	speed up = 0.5486611811629072
n =409600	fj time7579796	sequential time9618115	speed up = 1.2689147570726178
n =819200	fj time3892058	sequential time10198677	speed up = 2.6203815564927346
n =1638400	fj time5100492	sequential time20985336	speed up = 4.114374848544023
n =3276800	fj time4930390	sequential time10712944	speed up = 2.172839065469466
n =6553600	fj time7614000	sequential time23369949	speed up = 3.069339243498818
n =13107200	fj time15562503	sequential time49935426	speed up = 3.208701453744298
n =26214400	fj time31546042	sequential time89640415	speed up = 2.841574071320897
n =52428800	fj time47993644	sequential time114417091	speed up = 2.384005077839057

.5

n =50	fj time29203983	sequential time3769	speed up = 1.2905773845985324E-4
n =100	fj time375521	sequential time4783	speed up = 0.012736970768612141
n =200	fj time2973981	sequential time8927	speed up = 0.0030017004143604144
n =400	fj time542941	sequential time18681	speed up = 0.03440705343674543
n =800	fj time2771714	sequential time37884	speed up = 0.01366807686507338
n =1600	fj time3413171	sequential time76218	speed up = 0.02233055419725528
n =3200	fj time811409	sequential time127007	speed up = 0.15652648664237148

n =6400	fj time1413413	sequential time727150	speed up = 0.5144639252645901
n =12800	fj time896210	sequential time1586968	speed up = 1.7707546222425548
n =25600	fj time1822247	sequential time2350081	speed up = 1.2896610613160564
n =51200	fj time2032648	sequential time1455784	speed up = 0.7162007391343705
n =102400	fj time3680381	sequential time1216424	speed up = 0.33051578083899463
n =204800	fj time5031899	sequential time1901032	speed up = 0.37779613621020613
n =409600	fj time9481670	sequential time3981488	speed up = 0.4199142134244284
n =819200	fj time14341297	sequential time25495880	speed up = 1.7777945746469095
n =1638400	fj time5914988	sequential time1974423	speed up = 0.3338000009467475
n =3276800	fj time15388600	sequential time5088162	speed up = 0.33064489297272004
n =6553600	fj time11192173	sequential time29102101	speed up = 2.600219010195786
n =13107200	fj time21632220	sequential time15483414	speed up = 0.7157570512873852
n =26214400	fj time32107321	sequential time45963657	speed up = 1.4315631316608446
n =52428800	fj time39266723	sequential time46431489	speed up = 1.1824640676024836

.9

n =50	fj time13295516	sequential time2863	speed up = 2.153357568070318E-4
n =100	fj time1079932	sequential time4464	speed up = 0.004133593596633862
n =200	fj time485023	sequential time9466	speed up = 0.019516600243699785
n =400	fj time343029	sequential time17150	speed up = 0.049995772952141075
n =800	fj time259314	sequential time35910	speed up = 0.13848076077651034
n =1600	fj time390314	sequential time70855	speed up = 0.18153332957567497

n =3200	fj time404364	sequential time131987	speed up = 0.326406406109347
n =6400	fj time3430746	sequential time300251	speed up = 0.08751770023196122
n =12800	fj time640614	sequential time555041	speed up = 0.8664203404858464
n =25600	fj time1391990	sequential time1031627	speed up = 0.741116674688755
n =51200	fj time2398533	sequential time481304	speed up = 0.20066599041997754
n =102400	fj time3252986	sequential time935766	speed up = 0.28766370344046976
n =204800	fj time6998036	sequential time2193750	speed up = 0.3134808109018016
n =409600	fj time8015881	sequential time4421132	speed up = 0.5515466110337716
n =819200	fj time1292634	sequential time9327857	speed up = 7.216162502301502
n =1638400	fj time8579571	sequential time6367521	speed up = 0.74217242330648
n =3276800	fj time8631746	sequential time14891200	speed up = 1.7251666117144782
n =6553600	fj time5344544	sequential time12598817	speed up = 2.3573230943556642
n =13107200	fj time19836775	sequential time29098025	speed up = 1.4668727653562639
n =26214400	fj time29916426	sequential time53300778	speed up = 1.7816559371096
n =52428800	fj time41057193	sequential time84195386	speed up = 2.050685393908931

.1

n =50	fj time8223288	sequential time4039	speed up = 4.911660639880301E-4
n =100	fj time440027	sequential time4566	speed up = 0.010376635979155825
n =200	fj time725041	sequential time9580	speed up = 0.013213045882922483
n =400	fj time361952	sequential time20979	speed up = 0.057960724073910355
n =800	fj time450105	sequential time36483	speed up = 0.08105442063518513

n =1600	fj time495678	sequential time54951	speed up = 0.11086027622771234
n =3200	fj time1384190	sequential time153436	speed up = 0.11084894414784098
n =6400	fj time573159	sequential time296081	speed up = 0.5165774244145167
n =12800	fj time1079323	sequential time567581	speed up = 0.525867604044387
n =25600	fj time1670509	sequential time1646704	speed up = 0.9857498522905294
n =51200	fj time2822328	sequential time870542	speed up = 0.30844820304372844
n =102400	fj time2678369	sequential time560427	speed up = 0.2092418931073351
n =204800	fj time4294373	sequential time1764545	speed up = 0.41089700405623825
n =409600	fj time7498282	sequential time4410808	speed up = 0.5882424800774364
n =819200	fj time13987367	sequential time7824379	speed up = 0.5593889829300969
n =1638400	fj time31018019	sequential time18312951	speed up = 0.5903971817155699
n =3276800	fj time4420850	sequential time7425384	speed up = 1.6796281258129093
n =6553600	fj time10618063	sequential time10784228	speed up = 1.0156492761438691
n =13107200	fj time21100979	sequential time33518310	speed up = 1.5884717955503391
n =26214400	fj time33134838	sequential time41812047	speed up = 1.2618757031496577
n =52428800	fj time50633623	sequential time101833297	speed up = 2.0111793501326183

After running the fork join algorithm and the sequential algorithm on the same input, it is clear that the fork join algorithm is not consistently faster until the input size reaches at least 819200. This is because the amount of time it takes to create new threads plus the amount of time it takes to compare the results of those threads is longer than any sequential algorithm will be.

The fastest fraction used to determine the threshold was .3. When fork join is able to use more threads before it computes the result sequentially it makes the program go faster. Therefore, the smaller the fraction the faster it will go. However, when it is too small for example .1 it spends time creating threads and comparing them. So in order for fork join to work to its fullest potential we need a fraction that is small but not too small to allow enough threads for

substantial speed up but not too many threads that it will take longer to thread than just compute sequentially