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CS 475
Project 2 Write UP
4/24/2016

N-Body Calculation

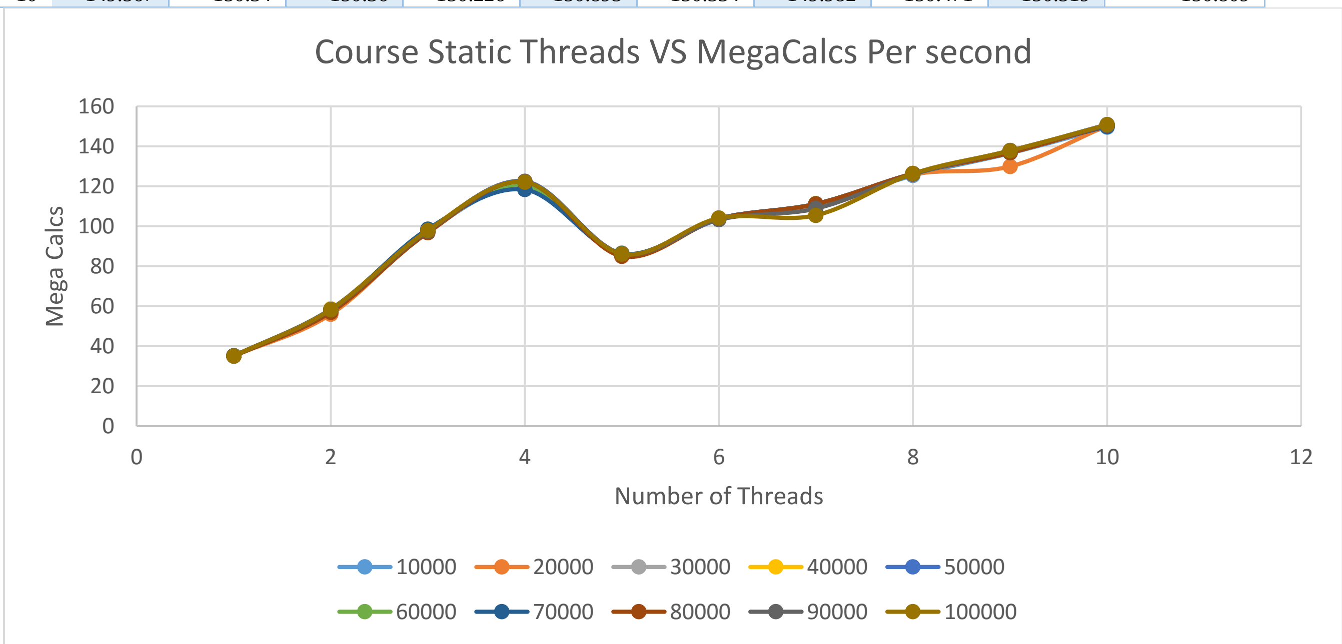
The Machine I ran this on was Flip, I ran very large data sets and collected A LOT of data. When I kicked off each of the 4 tests flip was sitting around 5-6% usage but each test took about 10 minutes to run so in that time the usage could have changed.

NOTE: I spent a solid 30 minutes trying to get the major information on to one graph in a way that made sense. I understand I was supposed to put it all on one graph but I failed to do so, so I apologize in advance. All my data and graphs are included in the zip folder as well.

Course Static: MegaCalcs Per Second

In this example we see what makes sense for speed up the more threads you use the more calculations per second you have. Pretty Straight forward. We see a sweet spot for reasonable number of threads at 4 threads. Then a decrease in the efficiency and then an steady slow increase all the way to 10 threads and the amount of megaCalcs per second.

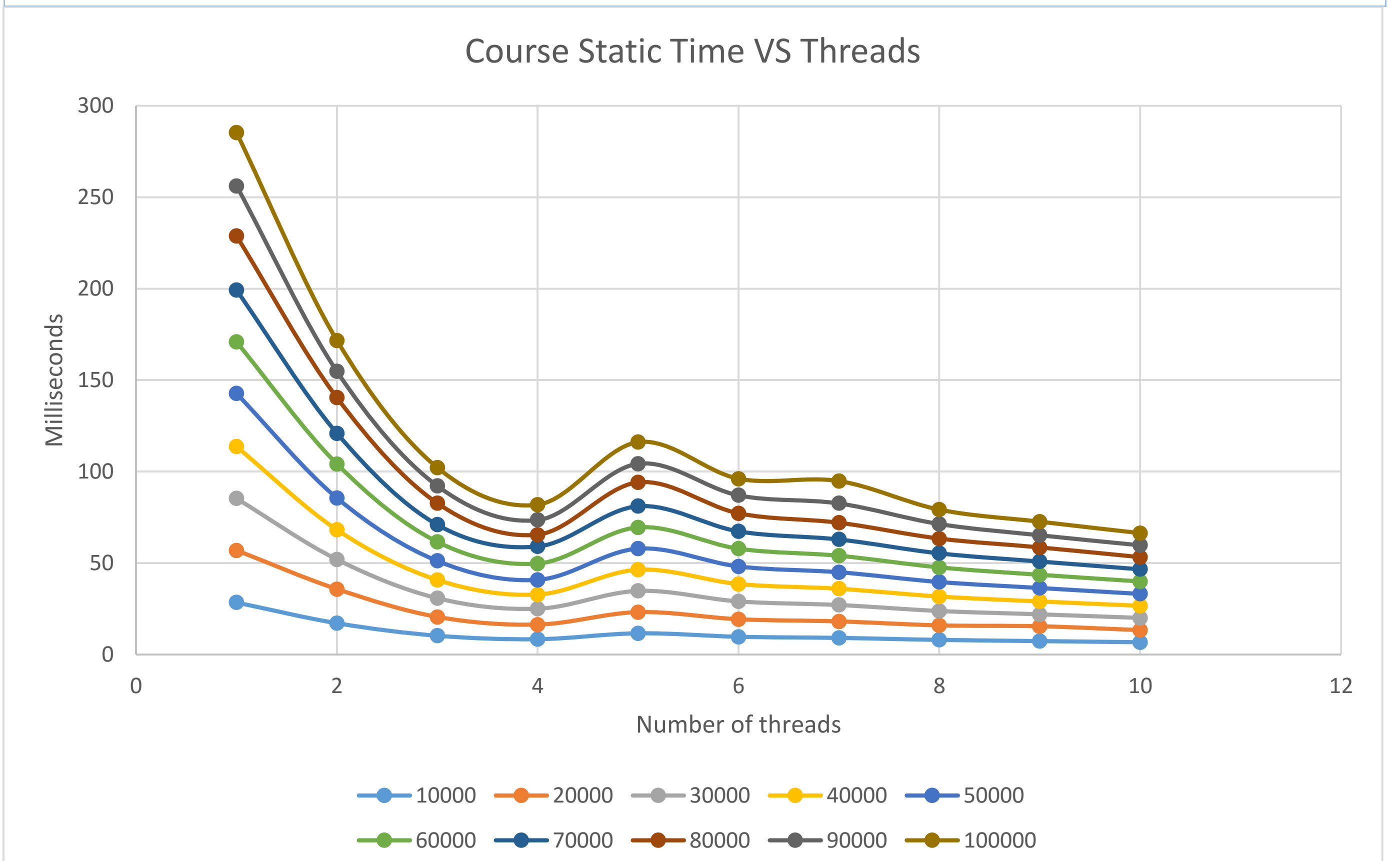
Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	35.15	35.1733	35.1534	35.1854	35.0476	35.1275	35.1488	34.968	35.1445	35.0538
2	58.451	56.0091	57.7536	58.6724	58.4436	57.6198	57.8811	56.9902	58.1735	58.2524
3	97.5027	97.5639	97.5593	98.1819	97.7317	97.4647	98.6001	96.7709	97.5904	97.8925
4	119.63	122.49	120.069	122.063	122.462	120.73	118.357	122.165	122.328	122.136
5	86.2803	86.5104	86.3443	86.2977	86.3569	86.3531	86.3019	85.0367	86.2805	86.1479
6	103.312	103.996	103.495	103.796	103.848	103.772	103.895	103.697	103.378	104.085
7	110.395	110.767	111.023	111.302	111.132	111.204	111.201	111.124	108.889	105.483
8	125.441	125.979	126.358	126.263	126.126	126.051	126.414	126.338	126.078	126.33
9	136.597	129.964	136.859	137.94	137.454	137.768	137.495	136.77	137.896	137.803
10	149.567	150.34	150.36	150.226	150.893	150.334	149.982	150.471	150.519	150.809



Course Static: Time to Calculate

Still on the same example as last time the more threads we use the smaller amount of time it takes although there is diminishing returns as we get to higher and higher numbers. Also at 5 threads we see an increase in the amount of time taken to calculate the information. This could be due to an increase on demand on the server, poor optimizations or the way that static broke the chunks up between the Threads.

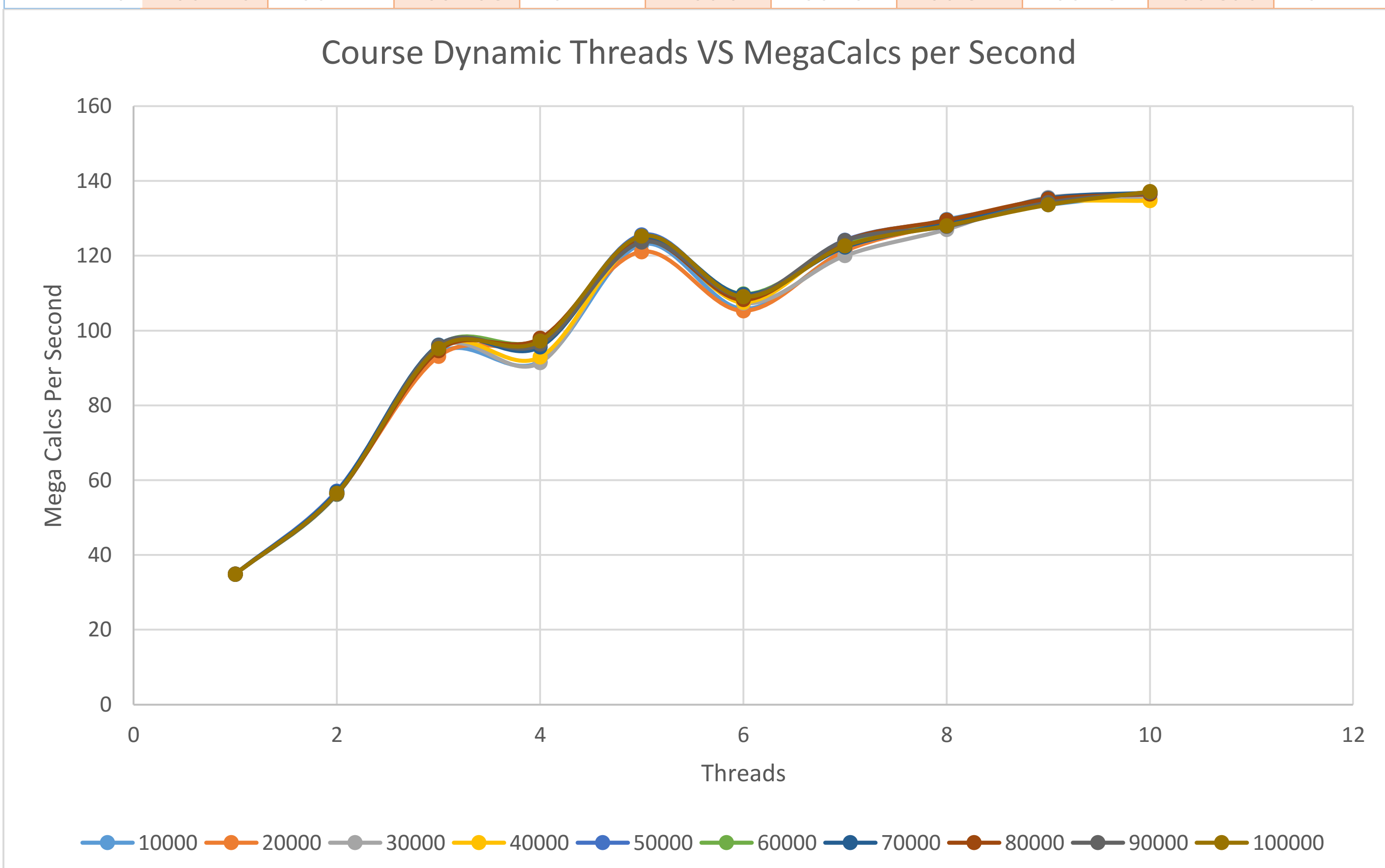
Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	28.4495	56.8613	85.3403	113.684	142.663	170.806	199.153	228.78	256.086	285.276
2	17.1084	35.7085	51.9448	68.1752	85.5526	104.131	120.938	140.375	154.71	171.667
3	10.2561	20.4994	30.7505	40.7407	51.1605	61.5607	70.9938	82.6695	92.2222	102.153
4	8.3591	16.3279	24.9856	32.7699	40.8289	49.6978	59.1432	65.4854	73.5724	81.8762
5	11.5901	23.1186	34.7446	46.3512	57.8992	69.4822	81.1106	94.077	104.311	116.079
6	9.67941	19.2315	28.987	38.5373	48.1471	57.819	67.3757	77.148	87.0594	96.0757
7	9.0584	18.056	27.0214	35.9384	44.9916	53.9551	62.9492	71.9915	82.653	94.802
8	7.97187	15.8756	23.7421	31.68	39.6429	47.5997	55.3736	63.3223	71.3842	79.1579
9	7.32079	15.3889	21.9204	28.9982	36.3757	43.5516	50.9109	58.4925	65.2667	72.5674
10	6.68598	13.3032	19.9522	26.6265	33.136	39.9111	46.6721	53.1663	59.7931	66.3091



Course Dynamic: MegaCalcs Per second

Much like the last example of course static, dynamic sees an increase in the amount of data calculated per second the more cores used. However instead of 5 threads being a drop in performance it was actually an increase in performance this could be attributed to dynamic re-assigning tasks to different threads if a task finished.

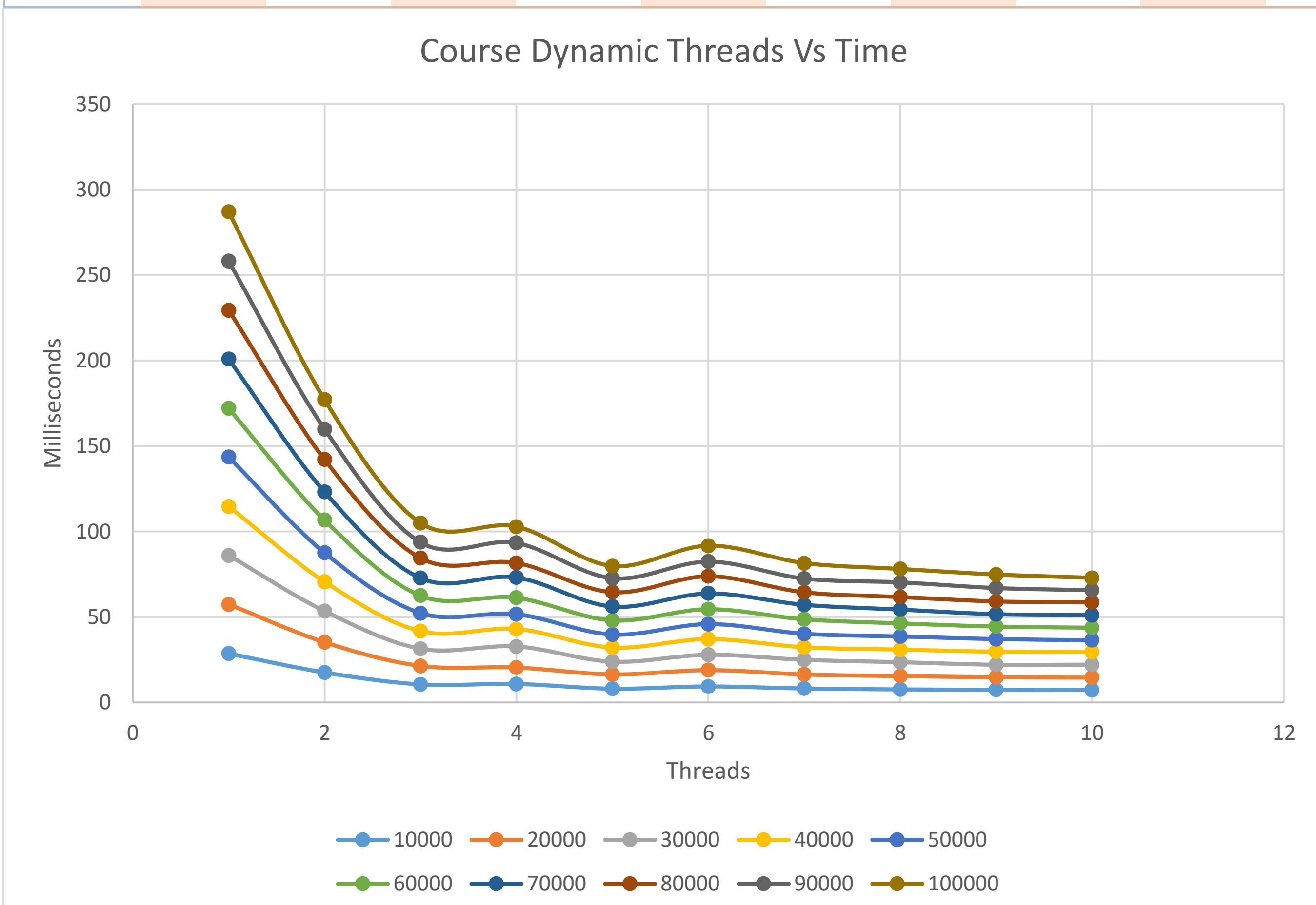
Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	34.8433	34.8482	34.8621	34.8617	34.8216	34.8588	34.8345	34.8608	34.8586	34.8437
2	56.7153	56.7261	56.1154	56.5784	57.0803	56.193	56.7924	56.2865	56.2725	56.4483
3	93.8319	93.0466	95.3113	95.7438	95.521	95.8809	96.0782	94.6172	95.963	95.1911
4	91.6725	97.3566	91.3984	92.9207	96.7	97.7602	95.6292	97.9118	96.3449	97.2162
5	123.075	121.076	125.337	124.174	125.553	124.61	124.565	123.877	123.654	125.244
6	105.83	105.28	107.316	107.559	108.842	109.779	109.624	108.269	109.099	109.04
7	121.36	121.246	119.992	123.617	124.131	123.022	122.257	124.009	124.047	122.638
8	129.723	128.533	127.026	129.076	129.276	129.306	128.602	129.52	127.87	128.045
9	133.603	134.353	135.571	134.252	134.479	134.78	135.324	135.122	134.231	133.623
10	136.723	136.421	135.198	134.724	136.91	136.797	136.844	136.481	136.896	137.127



Course Dynamic: Time to Calculate

This is just another way to look at the number of calculations per second but instead of examining how many per second it takes the problem as a whole and sees how long it took to complete the entire task. Just like the mega calcs per second the more threads used the faster the performance but there were diminishing returns after around 7 threads.

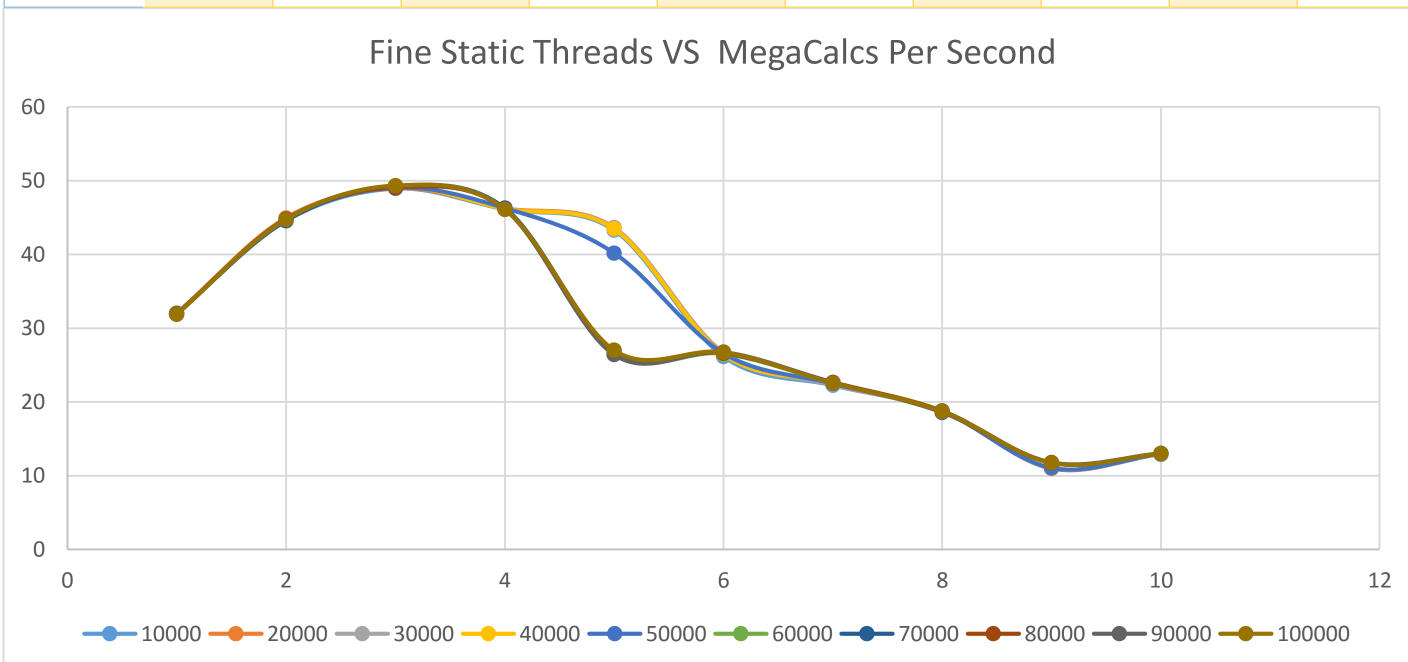
Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	28.7	57.3918	86.0533	114.739	143.589	172.123	200.95	229.484	258.186	286.996
2	17.6319	35.2571	53.4613	70.6983	87.5959	106.775	123.256	142.13	159.936	177.153
3	10.6574	21.4946	31.4758	41.7782	52.3445	62.5776	72.8573	84.5512	93.7862	105.052
4	10.9084	20.543	32.8233	43.0475	51.7063	61.3747	73.1994	81.7062	93.4144	102.863
5	8.1251	16.5186	23.9355	32.2128	39.8238	48.1502	56.1957	64.5804	72.7839	79.8439
6	9.44915	18.997	27.9549	37.189	45.9383	54.6554	63.8549	73.8903	82.4936	91.7093
7	8.23996	16.4954	25.0017	32.3579	40.28	48.7718	57.2565	64.5114	72.5533	81.5405
8	7.70874	15.5602	23.6172	30.9896	38.677	46.4017	54.4315	61.7666	70.3842	78.0978
9	7.48487	14.8862	22.1287	29.7948	37.1804	44.5171	51.7277	59.2058	67.0488	74.8372
10	7.31405	14.6605	22.1897	29.6904	36.5204	43.8606	51.1533	58.6161	65.7431	72.9251



Fine Static: MegaCalcs Per Second

Fine in general acted much different than Course. It would have an increase to around 3 or 4 threads and then a sharp decrease this could be attributed to the overhead of assigning so many small tasks to threads or to the fact that the problem was split up in to so many little problems. Because Unlike coarse which split up the problem in to NUMT big problems fine splits the problem in too many small problems. This difference is made by where the pragma is place either inside the outer for loop or inside the inner for loop.

Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	31.9796	32.0021	31.9593	32.0201	32.0205	31.8858	31.9764	31.8739	32.0182	31.95
2	44.59	44.9655	44.7991	44.7966	44.6904	44.7119	44.5718	44.8223	44.7804	44.7317
3	48.9393	49.0081	49.227	49.2046	49.0273	49.1081	49.2364	49.0504	49.2903	49.3146
4	46.1268	46.2683	46.1794	46.191	46.2717	46.2458	46.2767	46.1302	46.1047	46.1422
5	43.3065	43.631	43.59	43.4621	40.1713	26.6209	26.9375	26.6758	26.4178	27.0214
6	26.1679	26.672	26.5831	26.4538	26.596	26.5366	26.646	26.6235	26.7623	26.7366
7	22.2531	22.449	22.3345	22.6425	22.4958	22.5783	22.6669	22.656	22.6211	22.5709
8	18.7647	18.7856	18.7815	18.7937	18.7485	18.7818	18.7827	18.7447	18.5998	18.7387
9	11.0644	10.9779	11.0333	11.0786	11.0684	11.7529	11.7625	11.7291	11.8066	11.7609
10	12.9125	13.0049	12.9558	13.016	13.0214	13.0141	13.0117	13.0124	13.0198	12.9872

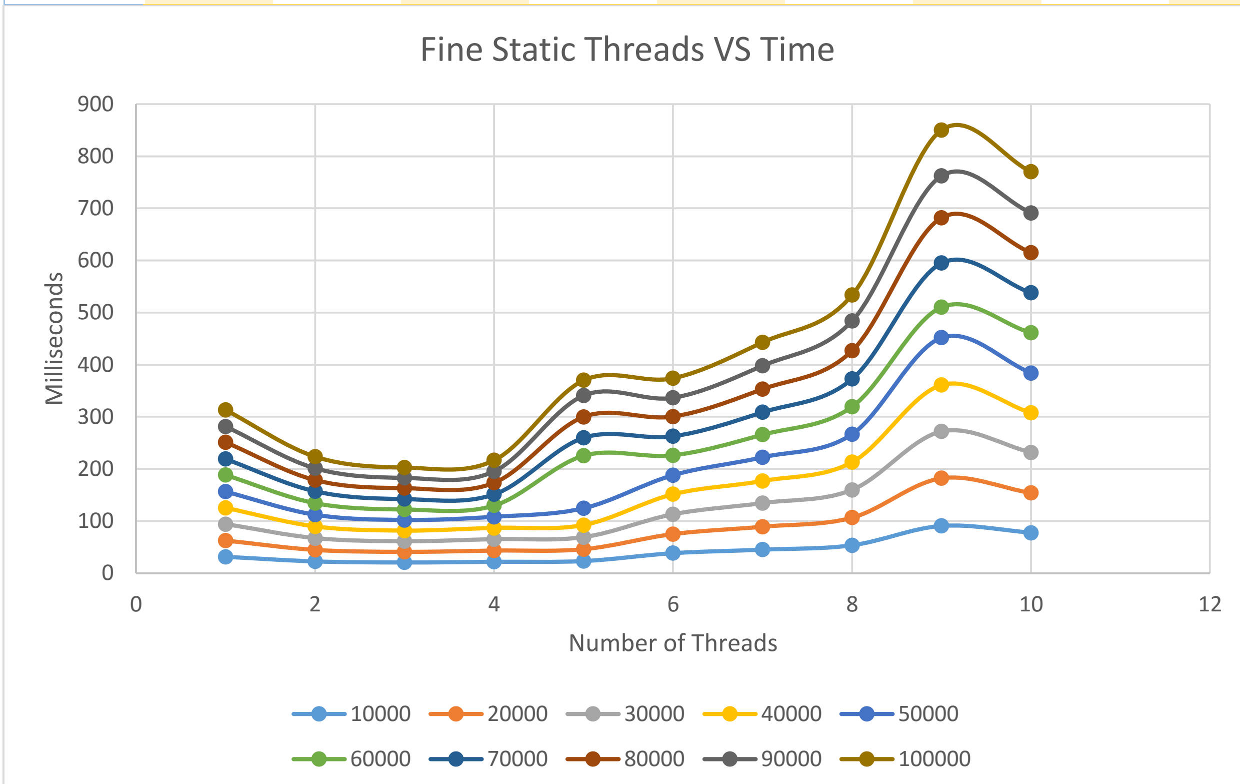


Fine Static: Time to Calculate

Just like the last graph this data is from the same sample which shows that as we use more threads the trend shows that it takes more time to calculate just like as it has fewer mega calcs per second. The weird split at around 5 threads is probably attributed to a temporary increase on CPU demand. The main thing to take away from this is Fine Static parallelism was effective till 3-4 threads after that it caused a steady decrease in the effects of parallelism.

Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	31.27	62.4958	93.8693	124.921	156.15	188.171	218.912	250.989	281.09	312.989
2	22.4266	44.4786	66.9656	89.2925	111.881	134.192	157.05	178.482	200.981	223.555
3	20.4335	40.8096	60.9422	81.2932	101.984	122.179	142.171	163.097	182.592	202.78
4	21.6794	43.2262	64.9641	86.5969	108.057	129.742	151.264	173.422	195.208	216.722
5	23.0912	45.8389	68.8232	92.0343	124.467	225.387	259.861	299.897	340.679	370.077
6	38.2148	74.9851	112.854	151.207	187.998	226.103	262.704	300.486	336.295	374.02

7	44.9376	89.091	134.321	176.659	222.264	265.742	308.82	353.108	397.858	443.049
8	53.2915	106.465	159.732	212.837	266.688	319.458	372.684	426.787	483.875	533.656
9	90.3797	182.184	271.904	361.055	451.735	510.511	595.11	682.062	762.286	850.278
10	77.4442	153.789	231.557	307.315	383.982	461.037	537.979	614.8	691.254	769.987

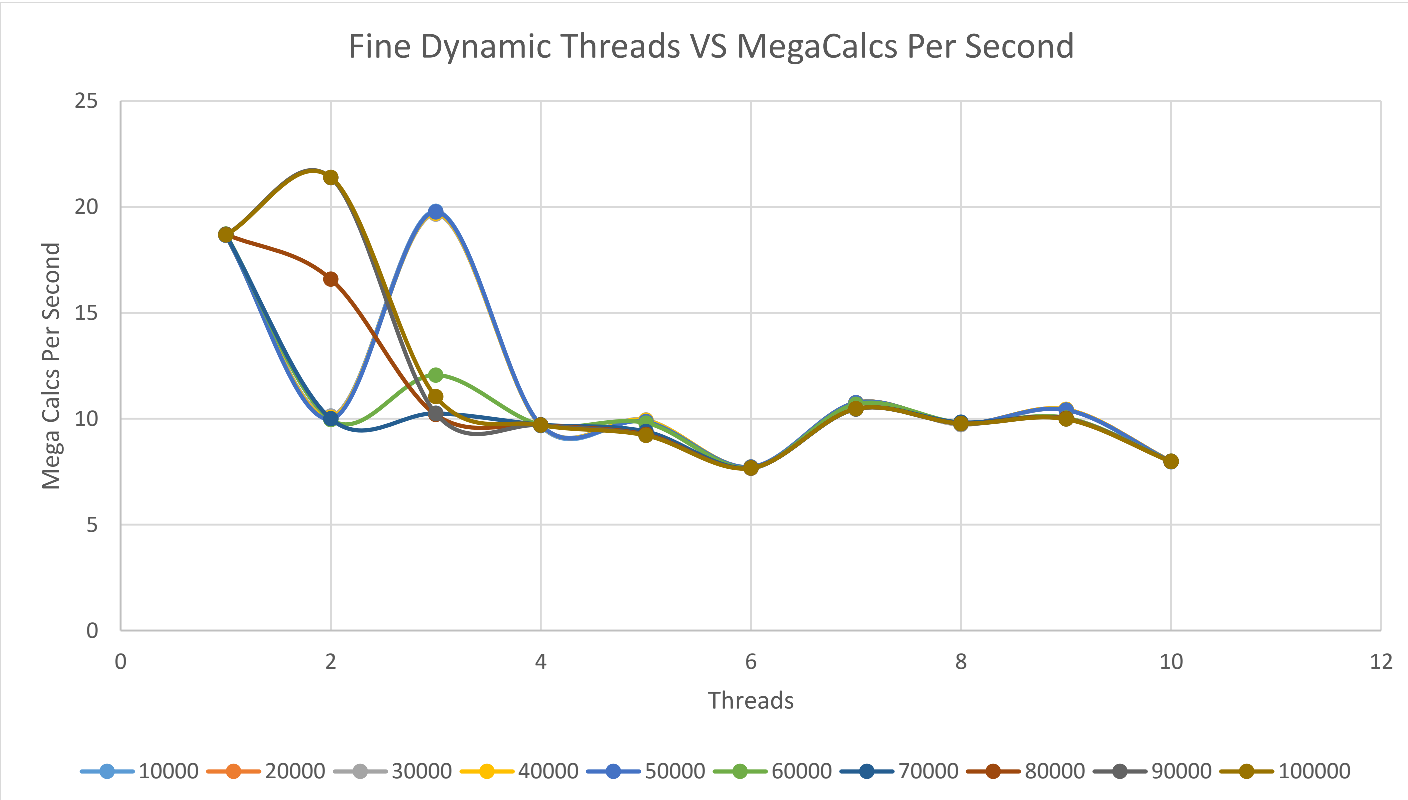


Fine Dynamic: MegaCalcs Per Second

In this case of parallelism, the fewer the threads used the more MegaCalcs per Second. This actually is very confusing to me and doesn't make sense I figured fine dynamic would have been more efficient then Fine static because it can move calculations between threads. That being said it does make sense that a few number of threads would be more efficient. Which is true, the weird graph is most likely attributed to an increase in cpu demand for a short period of time.

Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	18.6585	18.6721	18.668	18.6637	18.6622	18.7165	18.6966	18.7036	18.6785	18.6688
2	10.1255	10.0596	10.1273	10.0664	9.98302	9.95607	10.0031	16.585	21.3795	21.3962
3	19.7881	19.7414	19.6532	19.7012	19.7613	12.0544	10.2543	10.1945	10.2468	11.0494
4	9.66462	9.69733	9.69598	9.69238	9.70453	9.7019	9.721	9.70015	9.68768	9.70635
5	9.86339	9.88255	9.94433	9.92747	9.85857	9.7967	9.40078	9.26149	9.22162	9.22095
6	7.65678	7.66148	7.66216	7.71878	7.72482	7.67255	7.6784	7.67364	7.67571	7.67131
7	10.7608	10.7584	10.7385	10.7583	10.7544	10.6822	10.4566	10.4654	10.4576	10.4684
8	9.74103	9.76013	9.72115	9.76275	9.76726	9.80705	9.83025	9.77808	9.76515	9.78163
9	10.4305	10.4395	10.4222	10.4399	10.4153	10.0375	9.99659	10.0094	9.99188	9.98599

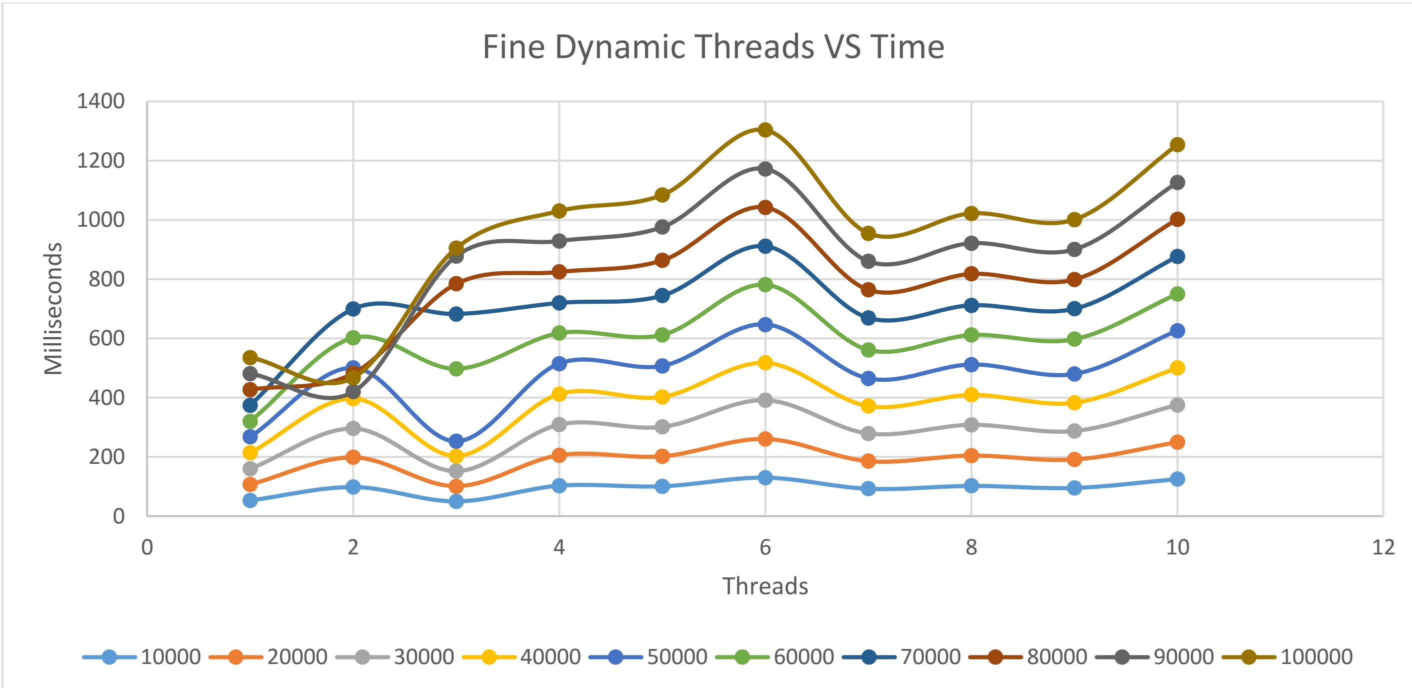
10	7.96299	7.99326	7.98393	7.99139	7.98112	7.99109	7.98227	7.97878	7.98995	7.97587



Fine Dynamic: Time to Calculate

Just like the megaCalcs per second graph, it was faster with fewer threads and then slowed down as more cores were added. This behavior is confusing to me. Although it would make sense that as more threads are added that it would slow down because more overhead is added to assigning tasks to the threads.

Threads	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
1	53.5947	107.112	160.703	214.319	267.922	320.573	374.4	427.726	481.838	535.654
2	98.7608	198.816	296.229	397.362	500.85	602.647	699.781	482.364	420.964	467.372
3	50.5354	101.31	152.647	203.034	253.02	497.742	682.64	784.739	878.323	905.024
4	103.47	206.242	309.407	412.695	515.223	618.436	720.09	824.729	929.015	1030.25
5	101.385	202.377	301.68	402.923	507.173	612.451	744.619	863.792	975.967	1084.49
6	130.603	261.046	391.535	518.217	647.264	782.008	911.648	1042.53	1172.53	1303.56
7	92.9299	185.901	279.368	371.804	464.924	561.684	669.434	764.426	860.616	955.252
8	102.659	204.915	308.606	409.721	511.914	611.804	712.088	818.157	921.645	1022.32
9	95.8727	191.58	287.848	383.146	480.064	597.757	700.239	799.252	900.731	1001.4
10	125.581	250.211	375.755	500.539	626.478	750.836	876.944	1002.66	1126.42	1253.78


Fine Dynamic Threads VS Time
Milliseconds
1400
1200
1000
800
600
400
200
0
0
2
4
6
8
10
12
Threads
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000