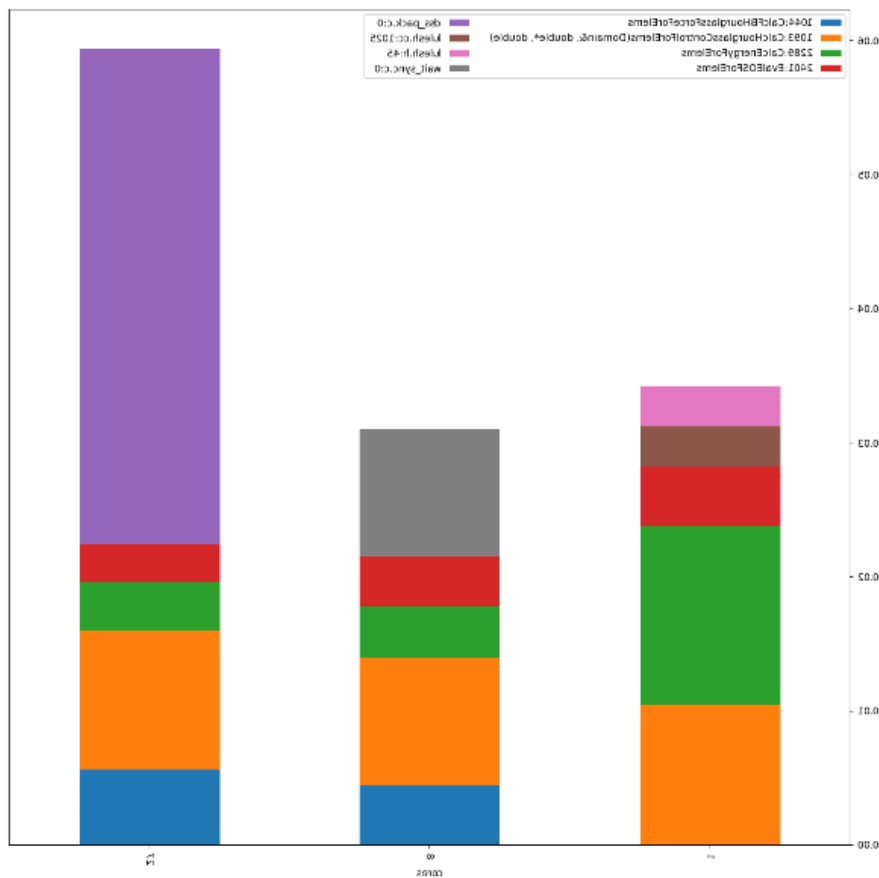


Task 1

Analysis:

From the data provided, we can see that for 1 MPI process, the CalcEnergyForElems function takes the most amount of time, followed by CalcHourglassControlForElems, and EvalEOSForElems. However, for 8 and 27 MPI processes, the wait_sync and dss_pack scripts take the most amount of time respectively, followed by CalcFBHourglassForceForElems. The simulation runs faster in 8 processes, then hangs up and becomes much slower at 27, compared to the serial execution. This indicates that the performance of the code deteriorates as we increase the number of processes passed 8, and the scaling is not efficient.

Visualizations:



Task 2

Analysis:

Comparing the results of 1 core strong and weak scaling, we can see that the functions that take the most time differ in each case. In the execution with the additional argument "-s 45", the function '2289:CalcEnergyForElems' takes the most time, followed by '1093:CalcHourglassControlForElems(Domain&)', while in the default execution, '1093:CalcHourglassControlForElems(Domain&)' takes the most time, followed by '2289:CalcEnergyForElems'. These two functions in each execution had similar runtimes, so they did not seem as affected by the scaling mode. However, in strong scaling, the 'CalculateMonotonicQGradientForElems' had a significant increase in runtime.

For 8 cores, weak and strong scaling, the results were somewhat similar, where '1093:CalcHourglassControlForElems(Domain&)' took the most time in both simulations. However, in strong scaling, dss_peek.c script took the second longest, while wait_sync.c took the second longest in the weak scaling case. Aside from this difference, the remaining functions seemed to be similar in proportion of execution time they take.

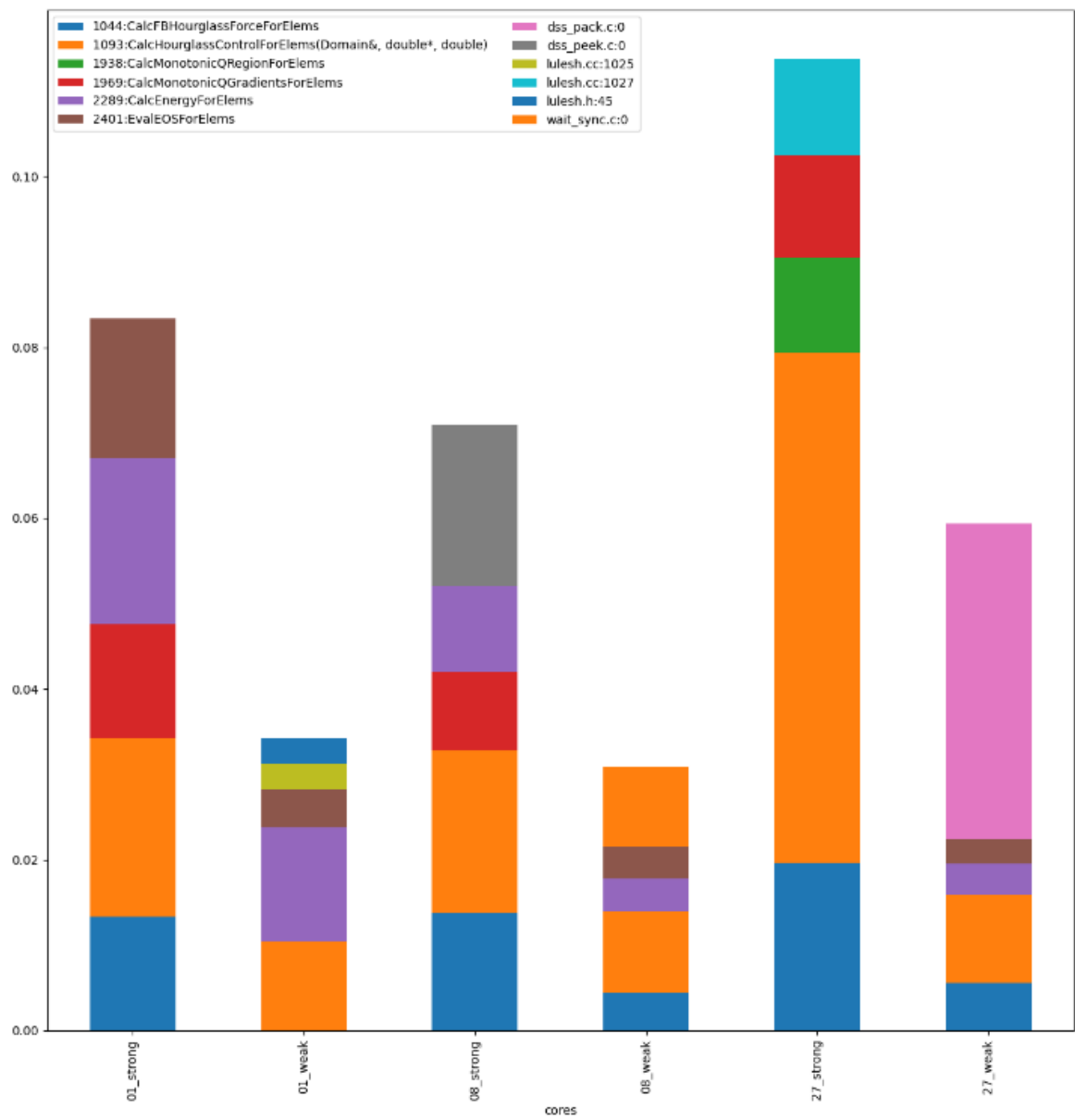
For 27 cores, weak and strong scaling, the results were much different than the simulation for 1 and 8 cores. The script dss_pack.c took the longest proportion of execution for weak scaling mode for 27 cores, while the CalcHourglassControlForElems function took the longest in the strong scaling mode.

Therefore, it seems that the CalcHourglassControlForElems function may be the bottleneck in the code. Between the weak and strong scaling mode for each set of comparisons, the CalcHourglassControlForElems seems to increase in proportion of total runtime of the simulation.

Visualizations:

	time (inc)	time	nid	...	line	module	cores
node				...			
{'name': '1093:CalcHourglassControlForElems(Dom...	0.095139	0.020853	181	...	998	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_strong
{'name': '2289:CalcEnergyForElems', 'type': 'fu...	0.055122	0.019366	379	...	2060	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_strong
{'name': '2401:EvalEOSForElems', 'type': 'funct...	0.087919	0.016399	365	...	2222	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_strong
{'name': '1969:CalcMonotonicQGradientsForElems'...	0.028272	0.013308	334	...	1619	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_strong
{'name': '1044:CalcFBHourglassForceForElems', '...	0.040097	0.013381	213	...	783	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_strong
[5 rows x 9 columns]							
	time (inc)	time	nid	...	line	module	cores
node				...			
{'name': '2289:CalcEnergyForElems', 'type': 'fu...	0.029739	0.013388	302	...	2060	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_weak
{'name': '1093:CalcHourglassControlForElems(Dom...	0.026781	0.010409	172	...	998	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_weak
{'name': '2401:EvalEOSForElems', 'type': 'funct...	0.044524	0.004418	280	...	2222	/scratch/z1/project/cmsc416/user/ekamil/Kamil...	01_weak
{'file': './src/scratch/z1/project/cmsc416/use...	0.002992	0.002992	176	...	1025	None	01_weak
{'file': './src/scratch/z1/project/cmsc416/use...	0.002983	0.002983	300	...	45	None	01_weak
[5 rows x 9 columns]							

			time (inc)	time	nid	...	line	module	cores
node									
						...			
{'name': '1093:CalcHourglassControlForElems(Dom...	0.189757	0.059626	2518	...	998	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_strong		
{'name': '1044:CalcFBHourglassForceForElems', '...	0.048605	0.019690	2697	...	783	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_strong		
{'name': '1969:CalcMonotonicQGradientsForElems'...	0.027019	0.011954	3520	...	1619	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_strong		
{'file': './src/scratch/zt1/project/cmsc416/use...	0.011279	0.011279	2525	...	1027	None	27_strong		
{'name': '1938:CalcMonotonicQRegionForElems', '...	0.022962	0.011233	3595	...	1771	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_strong		
[5 rows x 9 columns]									
			time (inc)	time	nid	...	line	module	cores
node									
						...			
{'file': 'dss_pack.c', 'line': '0', 'type': 'st...	0.036940	0.036940	1324	...	0	None	27_weak		
{'name': '1093:CalcHourglassControlForElems(Dom...	0.037821	0.010348	2118	...	998	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_weak		
{'name': '1044:CalcFBHourglassForceForElems', '...	0.013928	0.005613	2218	...	783	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_weak		
{'name': '2289:CalcEnergyForElems', 'type': 'fu...	0.008878	0.003636	2853	...	2060	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_weak		
{'name': '2401:EvalEOSForElems', 'type': 'funct...	0.015502	0.002817	2818	...	2222	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27_weak		
[5 rows x 9 columns]									
			time (inc)	time	nid	...	line	module	cores
node									
						...			
{'name': '1093:CalcHourglassControlForElems(Dom...	0.085155	0.019083	957	...	998	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_strong		
{'file': 'dss_peek.c', 'line': '0', 'type': 'st...	0.018941	0.018941	719	...	0	None	08_strong		
{'name': '1044:CalcFBHourglassForceForElems', '...	0.036235	0.013758	1030	...	783	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_strong		
{'name': '2289:CalcEnergyForElems', 'type': 'fu...	0.029450	0.010063	1569	...	2060	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_strong		
{'name': '1969:CalcMonotonicQGradientsForElems'...	0.021426	0.009131	1466	...	1619	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_strong		
[5 rows x 9 columns]									
			time (inc)	time	nid	...	line	module	cores
node									
						...			
{'name': '1093:CalcHourglassControlForElems(Dom...	0.035453	0.009481	760	...	998	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_weak		
{'file': 'wait_sync.c', 'line': '0', 'type': 's...	0.009417	0.009417	538	...	0	None	08_weak		
{'name': '1044:CalcFBHourglassForceForElems', '...	0.011660	0.004437	839	...	783	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_weak		
{'name': '2289:CalcEnergyForElems', 'type': 'fu...	0.012077	0.003901	1163	...	2060	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_weak		
{'name': '2401:EvalEOSForElems', 'type': 'funct...	0.021202	0.003727	1135	...	2222	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	08_weak		
[5 rows x 9 columns]									



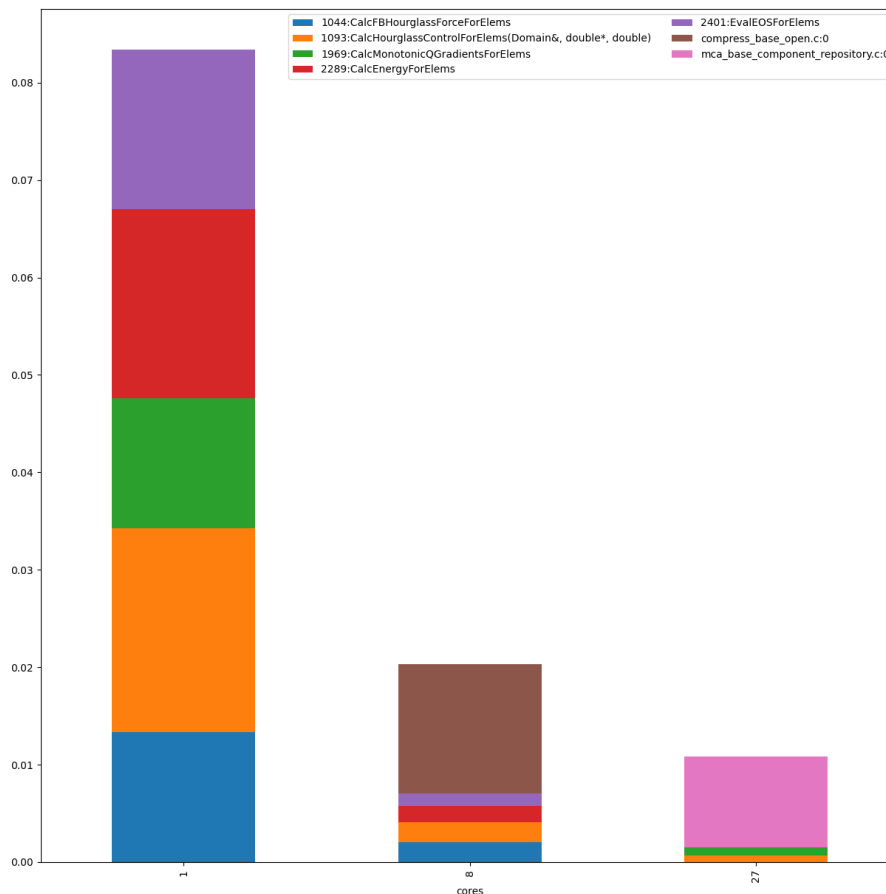
Task 3

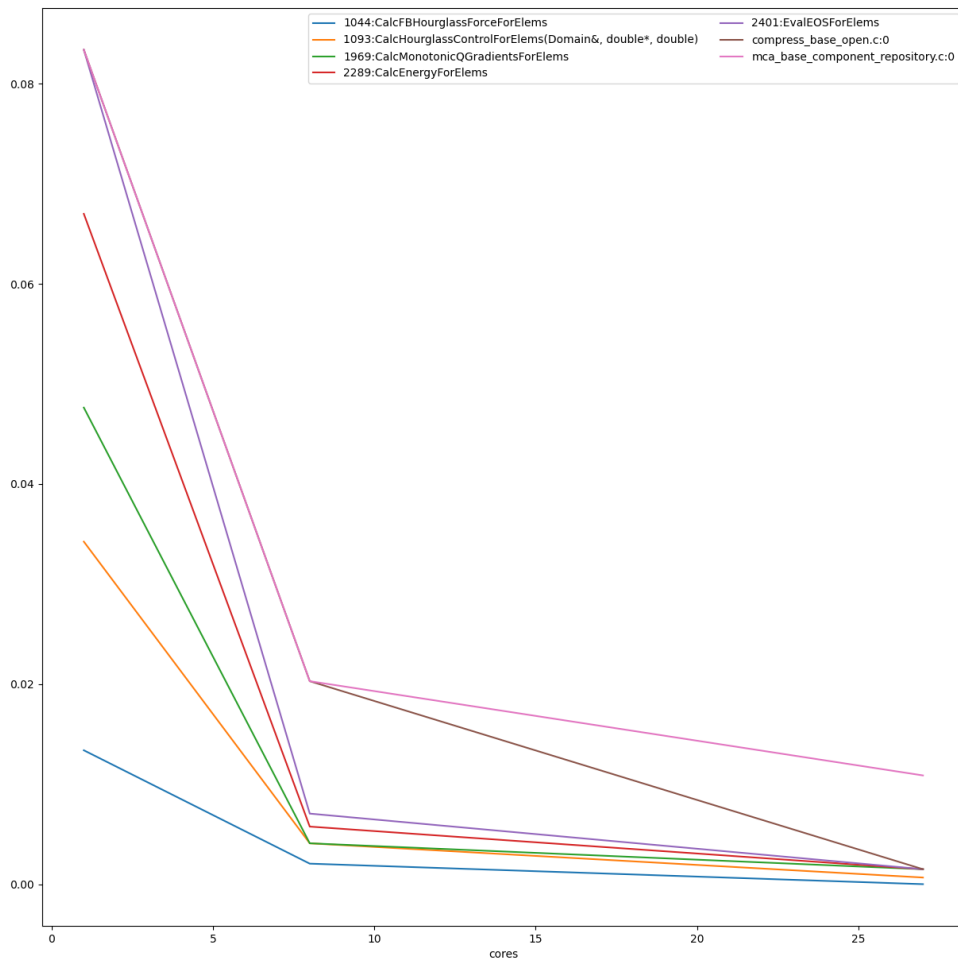
Analysis:

With a fixed problem size, the functions that did not scale well as more processors were added are `compress_base_open.c` in the simulation with 8 cores, along with `mca_base_component_repository.c` in the simulation with 27 cores.

Compared to task 1, where the problem size was not fixed, the functions that did not scale well were completely different. It seems with fixed problem size, the functions `dss_pack.c` and `wait_sync` were not present in the analysis, so they seem to not take a significant proportion of runtime in fixed problem sizes among multiple cores.

Visualizations:





node	time (inc)	time	nid	...	line	module	cores
{'name': '1093:CalcHourglassControlForElems(Dom...	0.095139	0.020853	181	...	998	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	1
{'name': '2289:CalcEnergyForElems', 'type': 'fu...	0.055122	0.019366	379	...	2060	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	1
{'name': '2401:EvalEOSForElems', 'type': 'funct...	0.087919	0.016399	365	...	2222	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	1
{'name': '1969:CalcMonotonicQGradientsForElems'...	0.028272	0.013398	334	...	1619	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	1
{'name': '1044:CalcFBHourglassForceForElems', '...	0.040097	0.013381	213	...	783	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	1
[5 rows x 9 columns]							
node	time (inc)	time	nid	...	line	module	cores
{'file': 'compress_base_open.c', 'line': '0', '...	0.013235	0.013235	589	...	0	None	8
{'name': '1044:CalcFBHourglassForceForElems', '...	0.005772	0.002050	725	...	783	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	8
{'name': '1093:CalcHourglassControlForElems(Dom...	0.010766	0.002033	704	...	998	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	8
{'name': '2289:CalcEnergyForElems', 'type': 'fu...	0.003341	0.001671	976	...	2060	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	8
{'name': '2401:EvalEOSForElems', 'type': 'funct...	0.006310	0.001298	956	...	2222	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	8
[5 rows x 9 columns]							
node	time (inc)	time	nid	...	line	module	cores
{'file': 'mca_base_component_repository.c', 'li...	0.021255	0.021255	901	...	0	None	27
{'file': 'mca_base_component_repository.c', 'li...	0.005505	0.005505	1453	...	0	None	27
{'file': 'mca_base_component_repository.c', 'li...	0.001363	0.001363	955	...	0	None	27
{'name': '1969:CalcMonotonicQGradientsForElems'...	0.001770	0.000830	2051	...	1619	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27
{'name': '1093:CalcHourglassControlForElems(Dom...	0.002874	0.000663	1732	...	998	/scratch/zt1/project/cmsc416/user/ekamil/Kamil...	27