CE8-AVS
Simon Loi Baks

Mini-Project Numerical Scientific Computing

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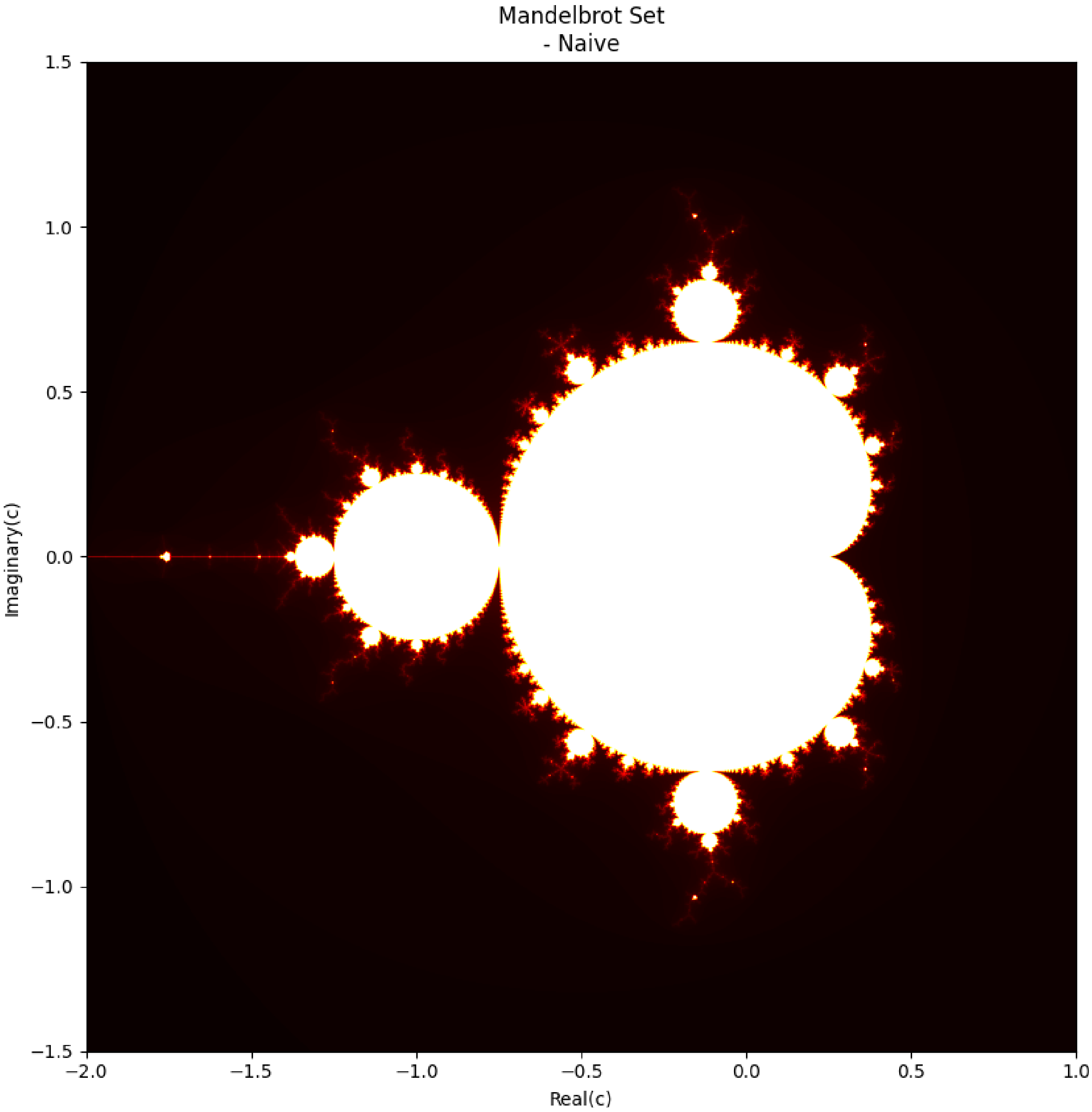
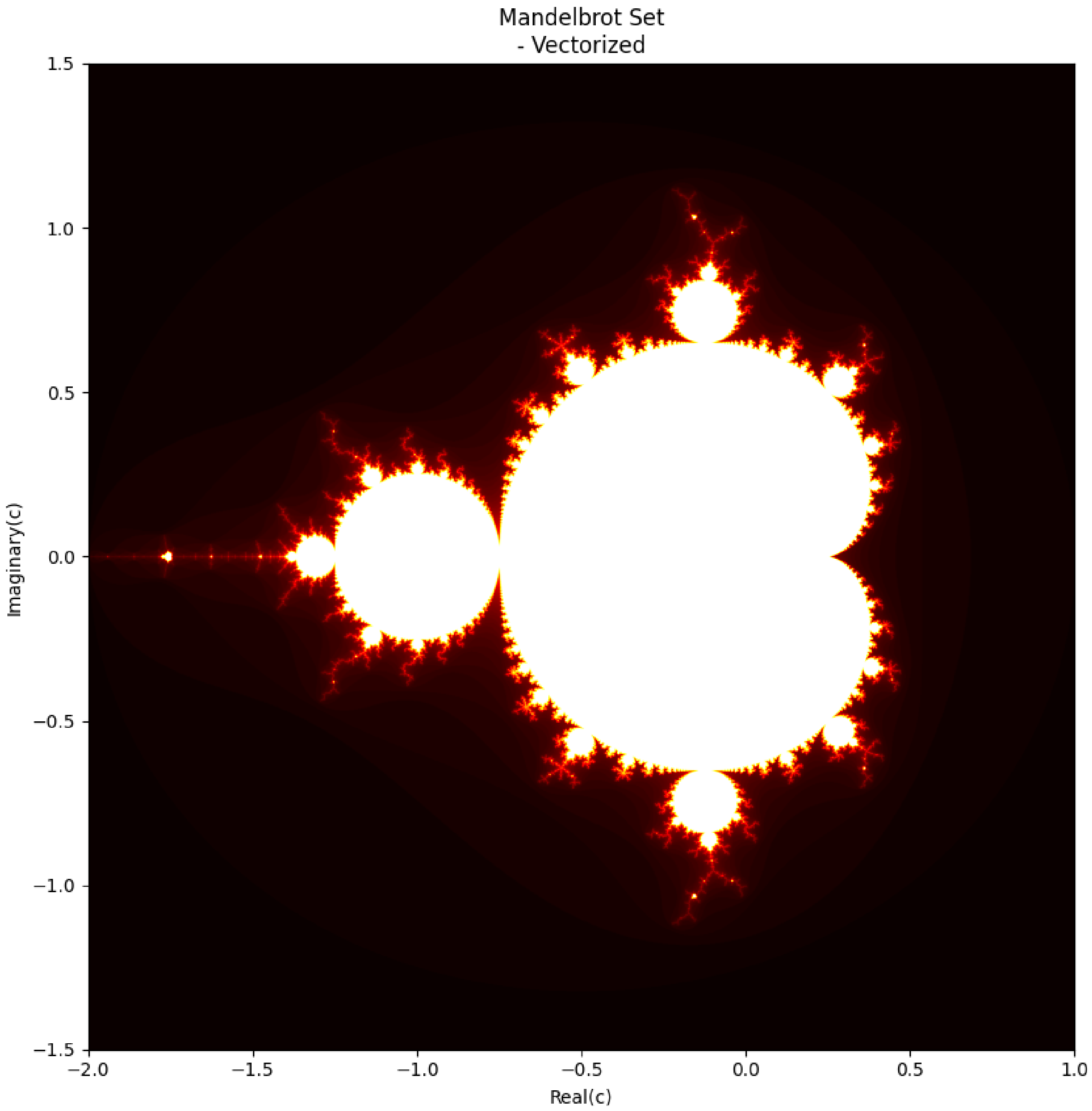
Visualization of the Mandelbrot Set

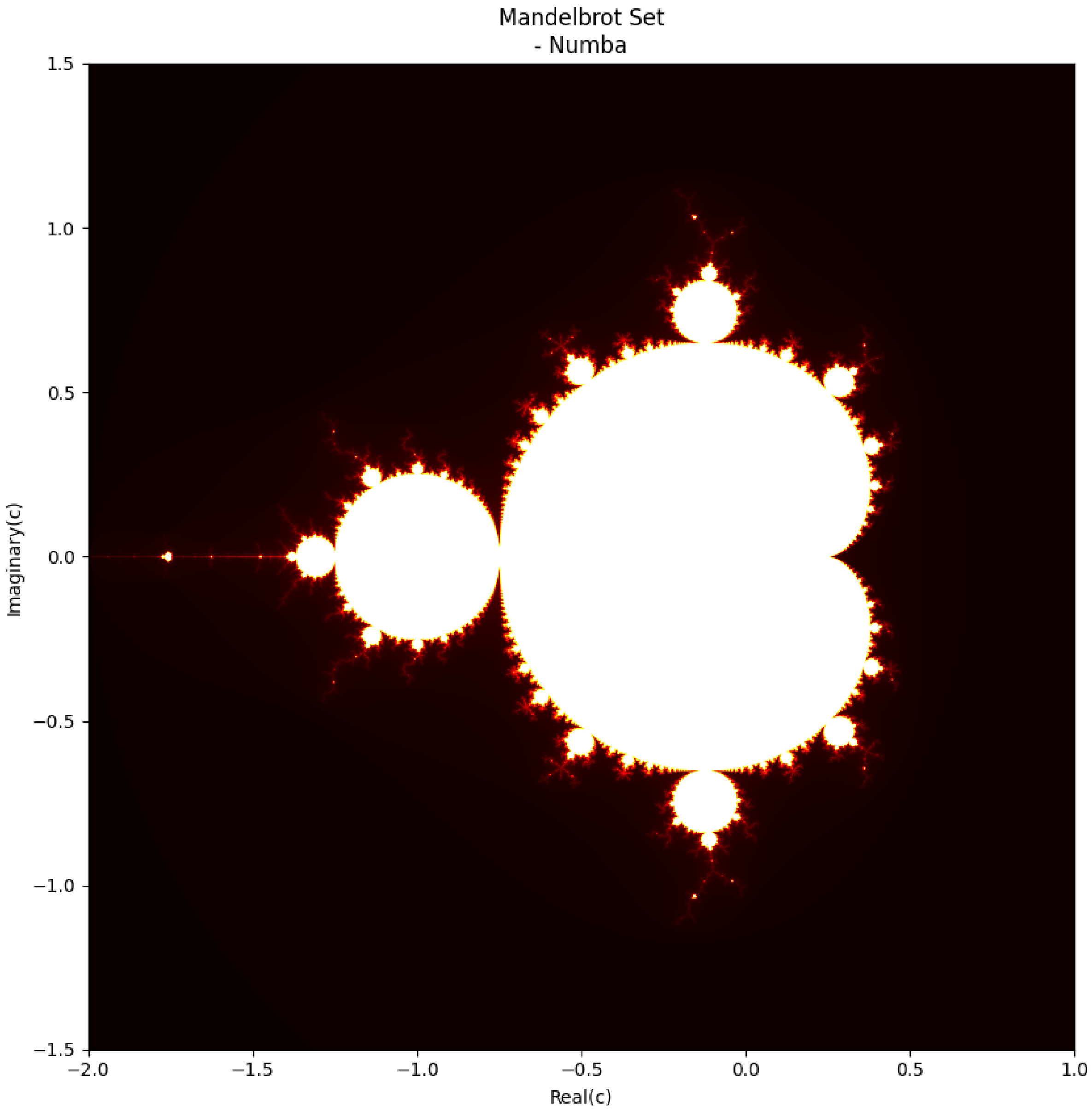
Naïve Algorithm



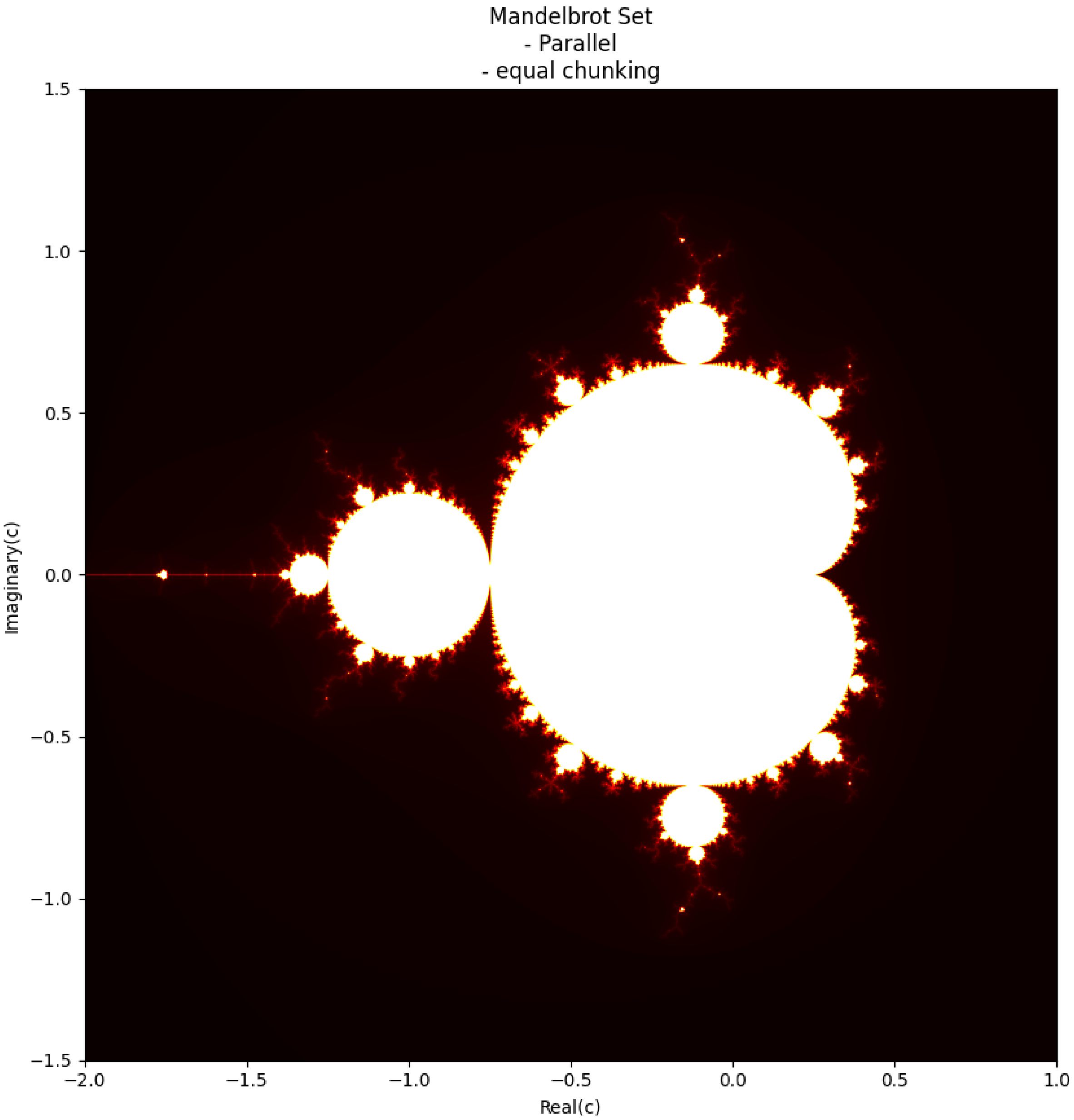
Vectorized Algorithm

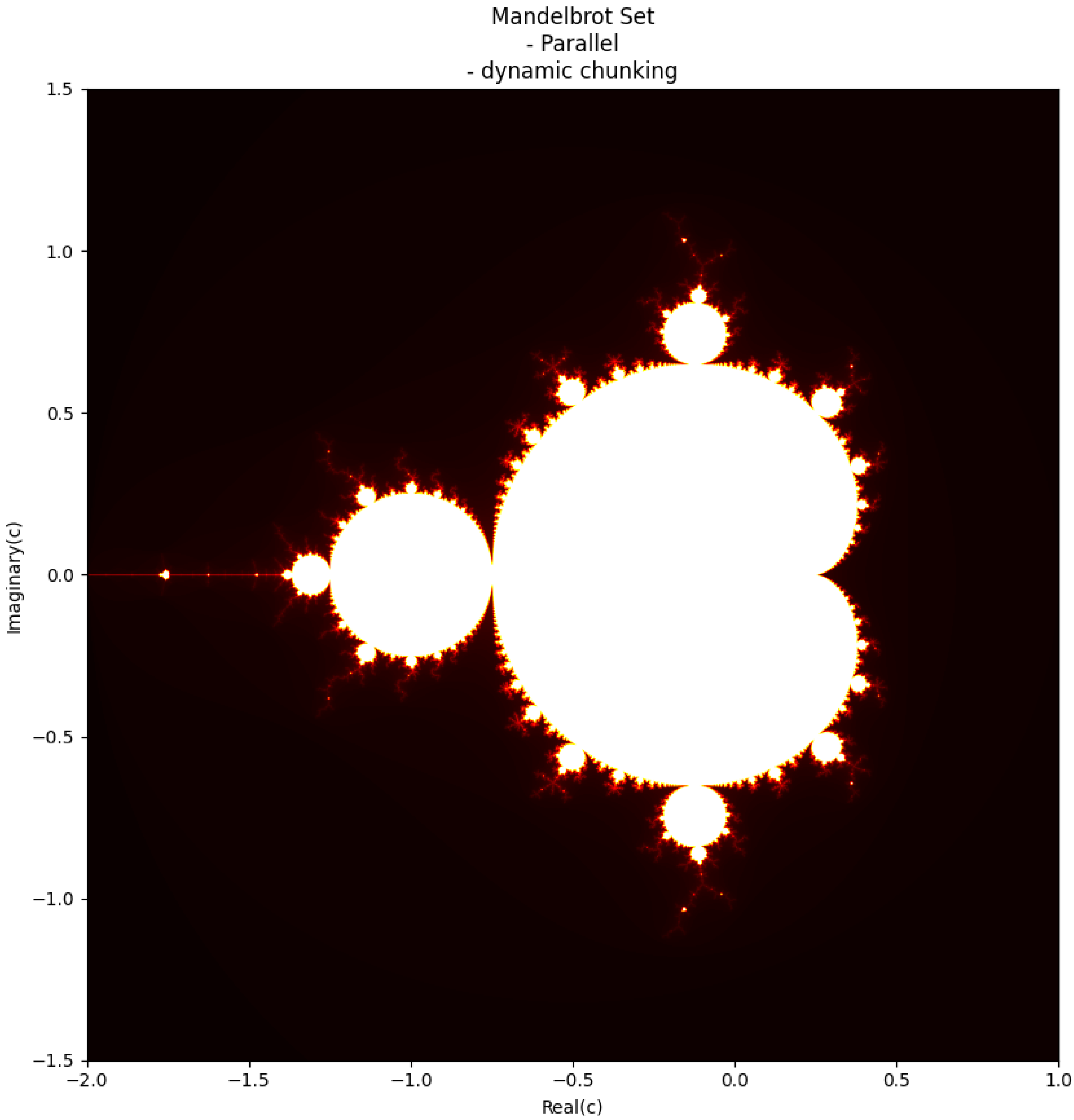


Numba Jit Algorithm



Multiprocessing Algorithm


Mandelbrot Set
- Parallel
- equal chunking
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
Imaginary(c)
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
Real(c)


Mandelbrot Set
- Parallel
- dynamic chunking
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
Imaginary(c)
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
Real(c)

Execution Times

Results show that multiprocessing compared to the naïve implementation is faster when the number of processes is greater than 1. As expected, the vectorized and numba jit algorithm is a lot faster than the naïve or multiprocessing.

Generally, the equal chunking algorithm performs slightly better than the dynamic algorithm, which may be due to the size of the image being 5000x5000. Perhaps the dynamic chunking would perform better for unevenly sized Mandelbrot images? (Not tested)

Algorithm	**Execution Time**
Naïve Algorithm	116.16s
Vectorized Algorithm	24.92s
Numba Jit Algorithm	1.39s

Multiprocessing Algorithm - Equal Chunking				
Processes	**Chunks**	**Chunk Size**	**Execution Time**	**Speedup**
1	1	5000	115.01s	1.0
2	2	2500,2500	57.61s	1.97
3	3	1666,1666,1668	80.03s	1.41
4	4	1250,1250,1250,1250	51.03s	2.25
5	5	1000,1000,1000,1000,1000	55.19s	2.10
6	6	833,833,833,833,833,835	42.92s	2.70
			Total: 401.39s	

Multiprocessing Algorithm - Dynamic Chunking				
Processes	**Chunks**	**Chunk Size**	**Execution Time**	**Speedup**
1	1	5000	114.25s	1.0
2	2	2500,2500	57.60s	1.97
3	3	1667,1667,1666	80.24s	1.39
4	4	1250,1250,1250,1250	50.39s	2.22
5	5	1000,1000,1000,1000,1000	55.21s	2.02
6	6	834,834,833,833,833,833	42.92s	2.71
			Total: 400.62s	

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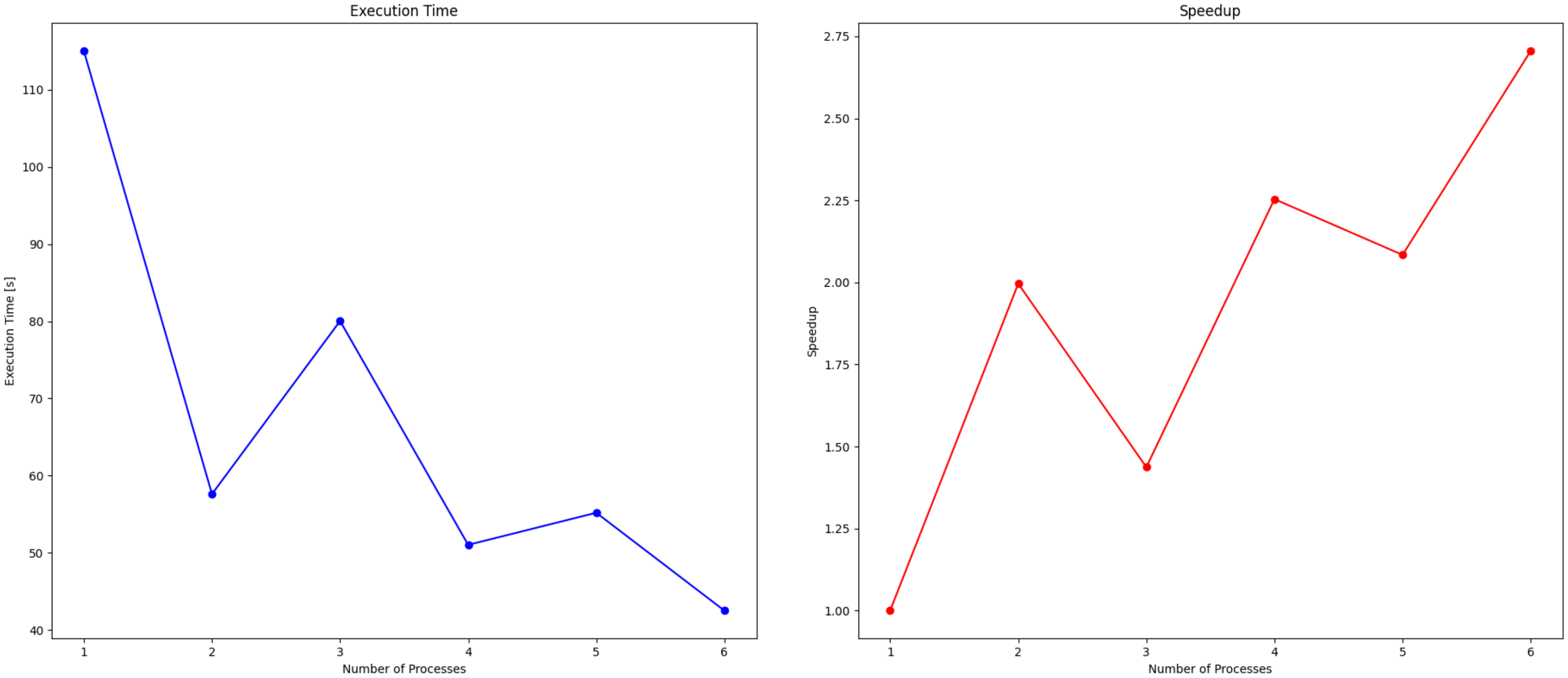
Performance Analysis of Parallel Mandelbrot Algorithm
Chunking: equal



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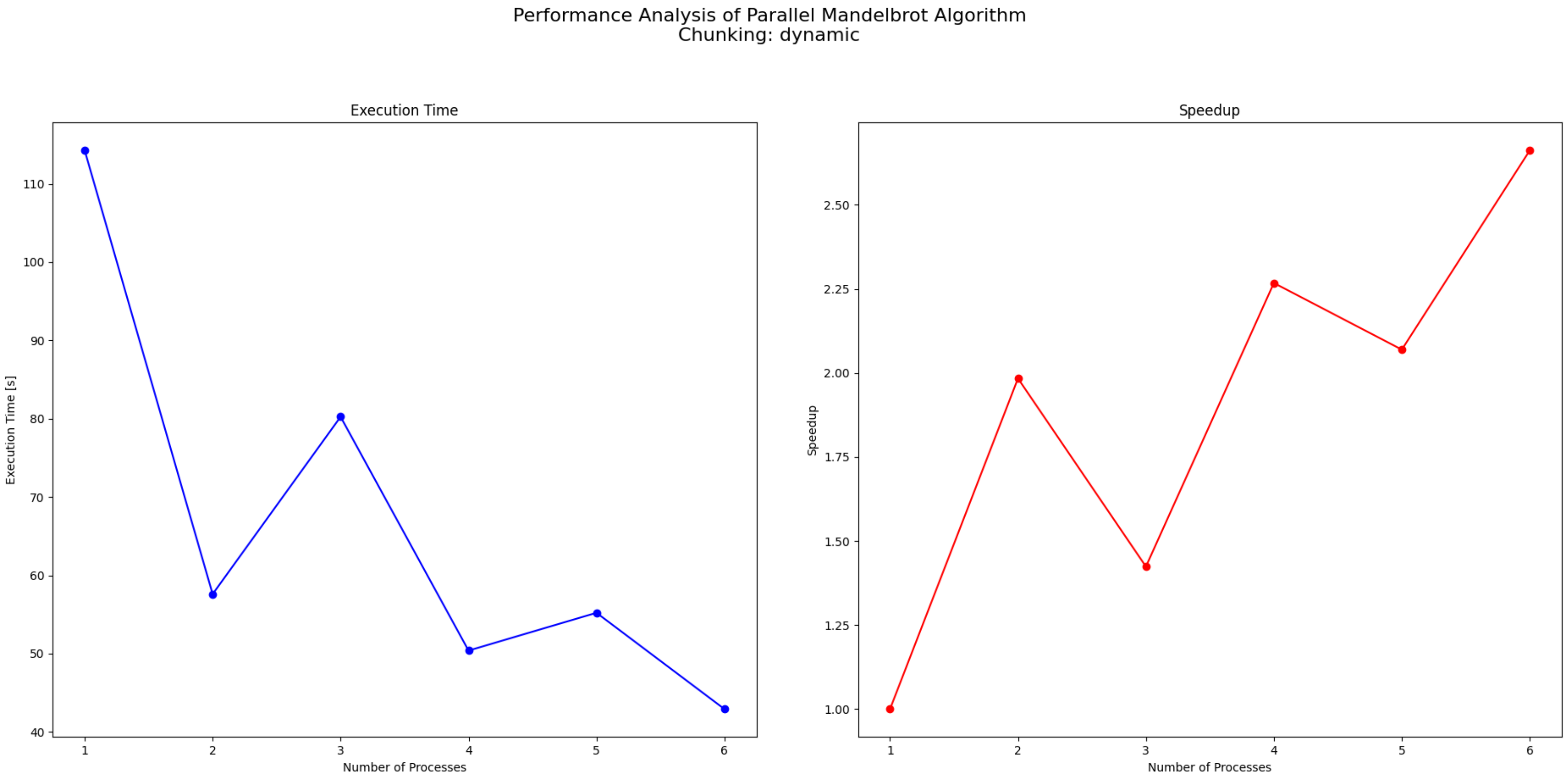

Performance Analysis of Parallel Mandelbrot Algorithm
Chunking: dynamic