Problem 2

소프트웨어학부 20204898 박소은

Environment

- **Processor**: Intel(R) Core(TM) i7-1065G7 CPU @ 1.30GHz   1.50 GHz
- **Number of cores**: 4
- **RAM**: 16.0GB
- **OS**: Window 11 (64 bit)

Tables and graphs

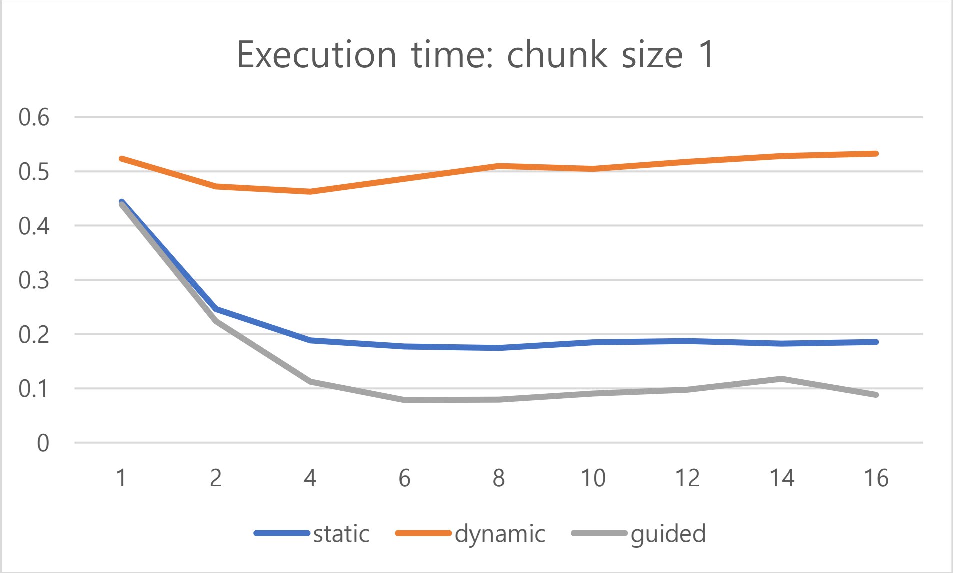
Execution time

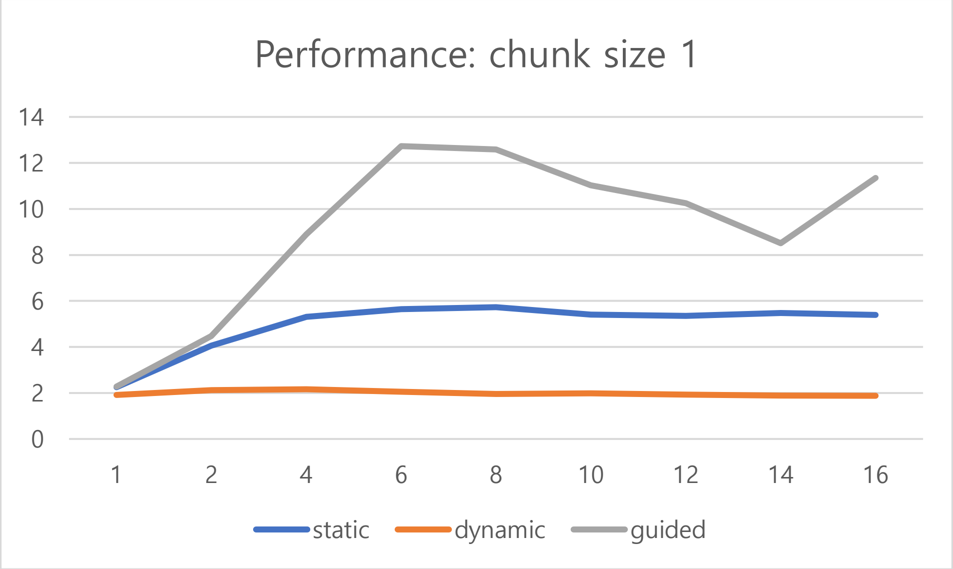
exec time	chunk size	1	2	4	6	8	10	12	14	16
static	1	0.444291	0.246296	0.188144	0.177182	0.17452	0.18497	0.187023	0.182787	0.18554
dynamic		0.523303	0.472047	0.46261	0.486447	0.509843	0.504809	0.517833	0.528168	0.532738
guided		0.439086	0.22355	0.11241	0.078545	0.079472	0.090731	0.097595	0.117503	0.088084
static	5	0.435648	0.242498	0.155559	0.128669	0.149407	0.137178	0.141968	0.157498	0.14254
dynamic		0.450172	0.404378	0.335581	0.330263	0.340171	0.338306	0.335508	0.335836	0.352766
guided		0.446144	0.2154	0.109825	0.080536	0.085715	0.079979	0.087289	0.075839	0.09547
static	10	0.443584	0.241867	0.151993	0.14062	0.133576	0.132264	0.134204	0.126253	0.141576
dynamic		0.463189	0.363377	0.310272	0.285163	0.294232	0.295213	0.301459	0.332782	0.302244
guided		0.467248	0.224505	0.116302	0.089851	0.081728	0.094305	0.090735	0.100114	0.091296
static	100	0.449662	0.23416	0.174131	0.123938	0.126779	0.133901	0.137898	0.09752	0.082855
dynamic		0.445432	0.192383	0.106857	0.080091	0.090317	0.097189	0.105372	0.097958	0.084178
guided		0.450153	0.224617	0.110209	0.080666	0.08254	0.078047	0.075459	0.107674	0.099522

Performance

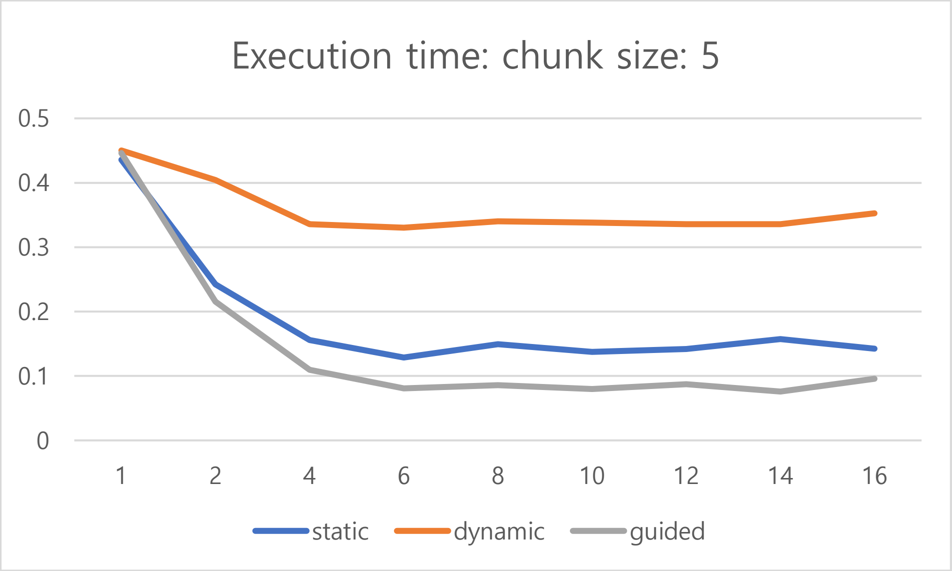
performance	chunk size	1	2	4	6	8	10	12	14	16
static	1	2.250777	4.060155	5.315078	5.643914	5.730002	5.406282	5.346936	5.470849	5.389673
dynamic		1.910939	2.118433	2.161648	2.055722	1.961388	1.980947	1.931125	1.893337	1.877095
guided		2.277458	4.473272	8.896006	12.73156	12.58305	11.02159	10.24643	8.510421	11.3528
static	5	2.295431	4.123745	6.428429	7.77188	6.693127	7.289799	7.043841	6.349287	7.015575
dynamic		2.221373	2.472934	2.979906	3.02789	2.939698	2.955904	2.980555	2.977644	2.83474
guided		2.241429	4.642526	9.105395	12.41681	11.66657	12.50328	11.4562	13.18583	10.47449
static	10	2.254364	4.134504	6.57925	7.111364	7.486375	7.560636	7.451343	7.920604	7.063344
dynamic		2.158946	2.751963	3.222979	3.506766	3.398679	3.387385	3.317201	3.00497	3.308585
guided		2.140191	4.454244	8.598304	11.12954	12.23571	10.60389	11.02111	9.988613	10.95338
static	100	2.223893	4.270584	5.742803	8.06855	7.887742	7.468204	7.251737	10.25431	12.06928
dynamic		2.245012	5.197964	9.358301	12.4858	11.07211	10.28923	9.490187	10.20846	11.87959
guided		2.221467	4.452023	9.073669	12.3968	12.11534	12.81279	13.25223	9.287293	10.04803

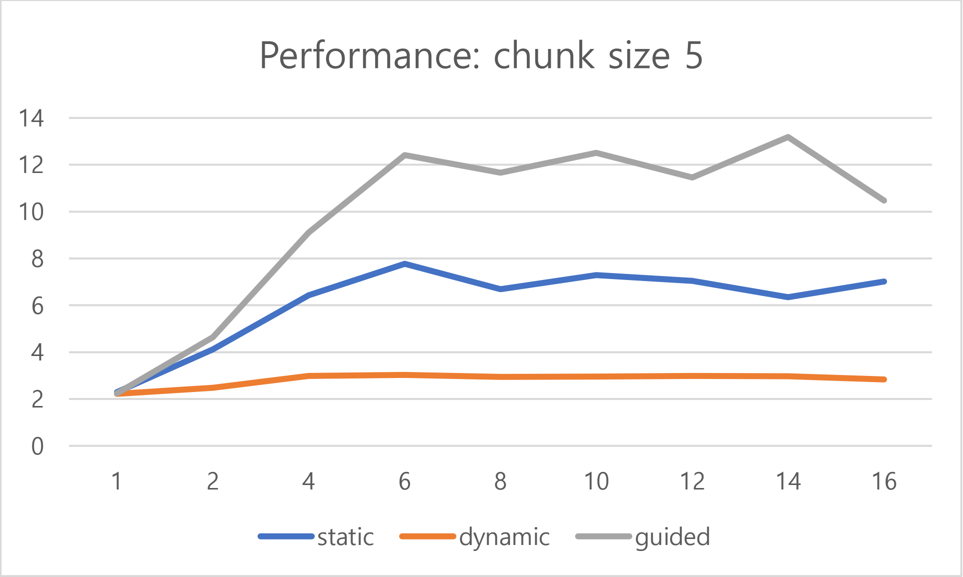
Chunk size: 1


Execution time: chunk size 1
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
4
6
8
10
12
14
16
static
dynamic
guided

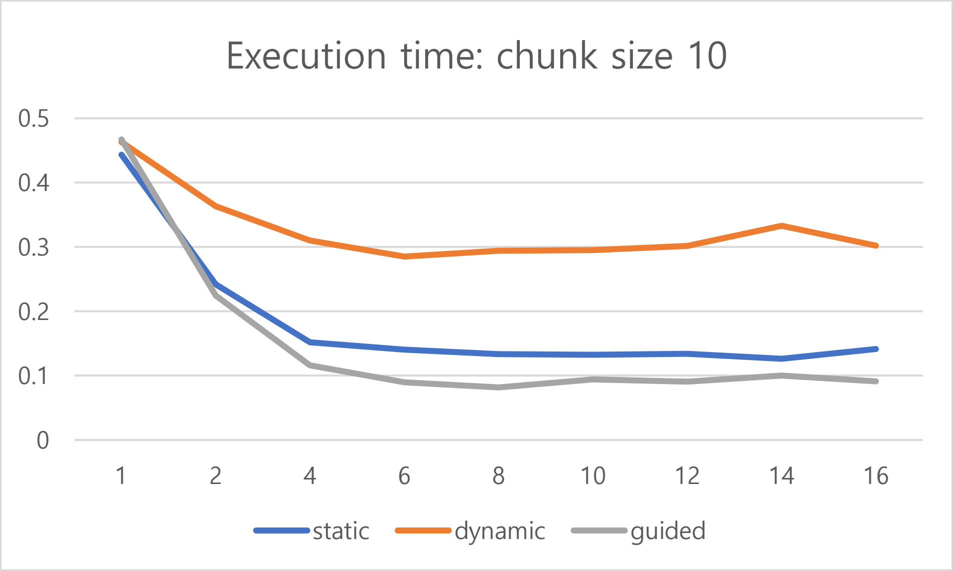

Performance: chunk size 1
14
12
10
8
6
4
2
0
1
2
4
6
8
10
12
14
16
static
dynamic
guided

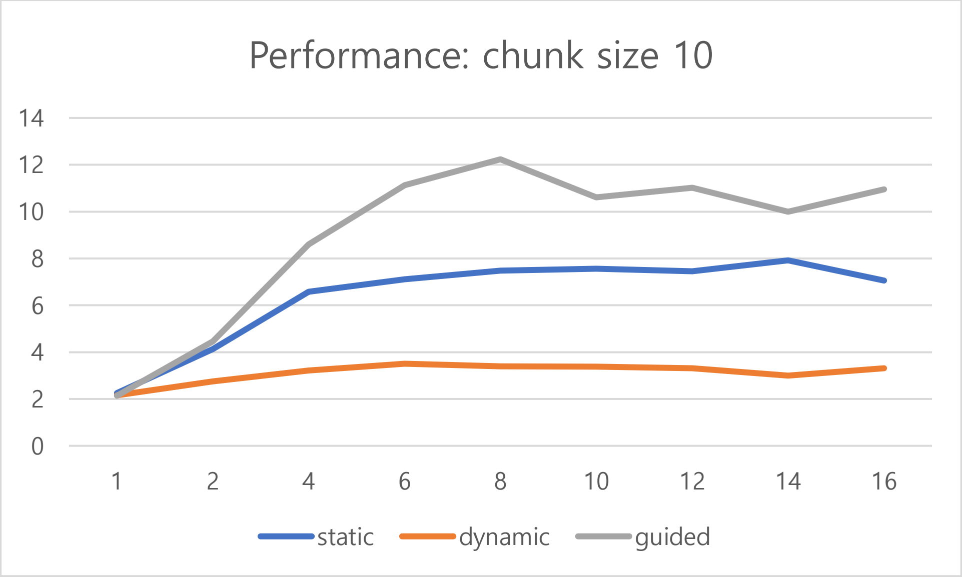
Chunk size: 5


Execution time: chunk size: 5
0.5
0.4
0.3
0.2
0.1
0
1
2
4
6
8
10
12
14
16
static
dynamic
guided

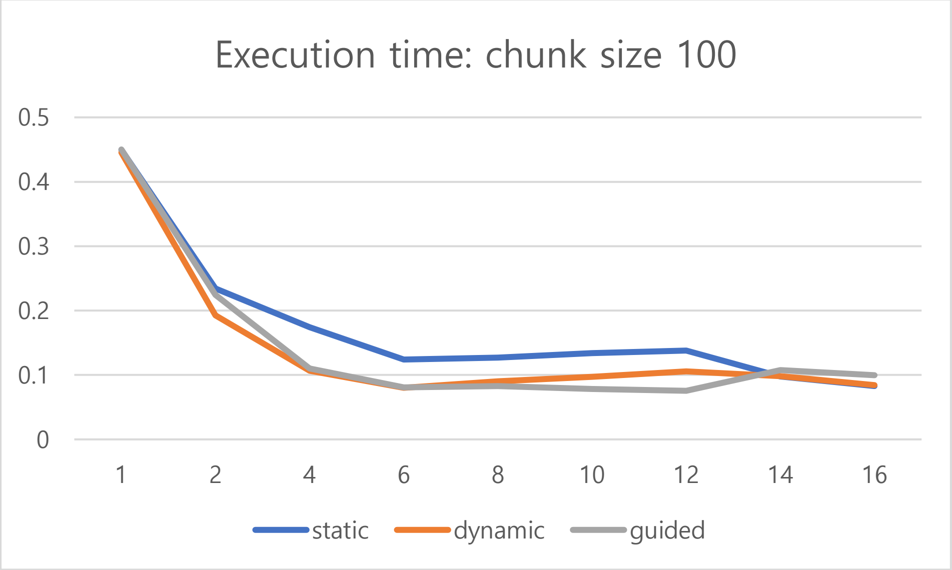

Performance: chunk size 5
14
12
10
8
6
4
2
0
1
2
4
6
8
10
12
14
16
static
dynamic
guided

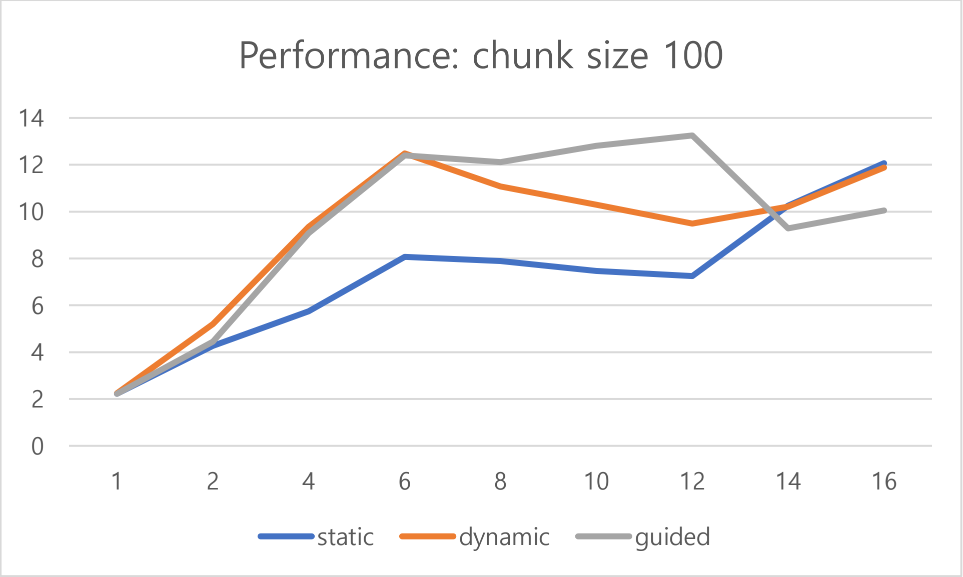
Chunk size: 10





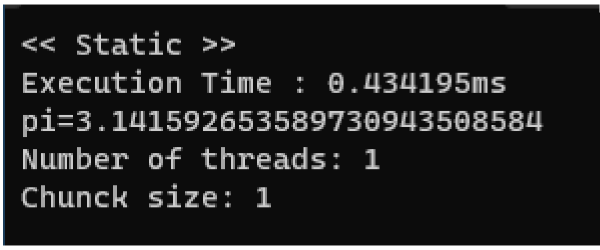
Chunk size: 100



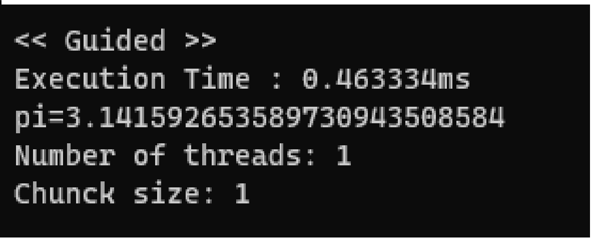


Explanation / Analysis

Regardless of the chunk size or scheduling type, it can be seen that when the number of threads is one, similar performance comes out.

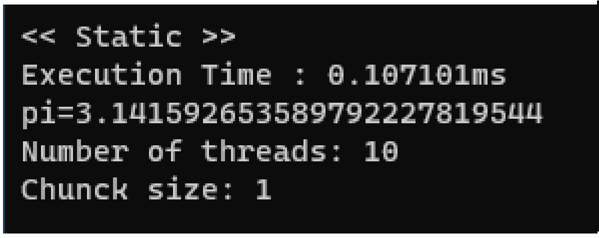


```
<< Static >>
Execution Time : 0.434195ms
pi=3.141592653589730943508584
Number of threads: 1
Chunck size: 1
```

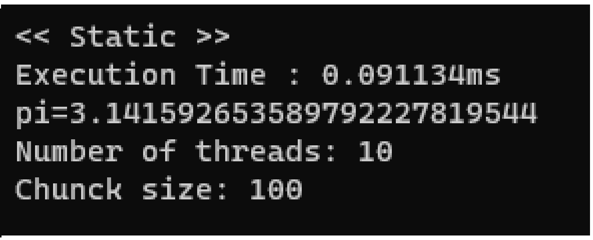


```
<< Guided >>
Execution Time : 0.463334ms
pi=3.141592653589730943508584
Number of threads: 1
Chunck size: 1
```

In the case of static scheduling, the larger the chunk size, the higher the performance from 5.38 (chunk size: 1) to 12.06 (chunk size: 100). When the chunk size is small, one thread is responsible for only one for statement, so the switching time of the threads was longer than the execution time of the for statement, resulting in lower performance. In addition, compared to other scheduling types, static scheduling has the second highest performance after guided.

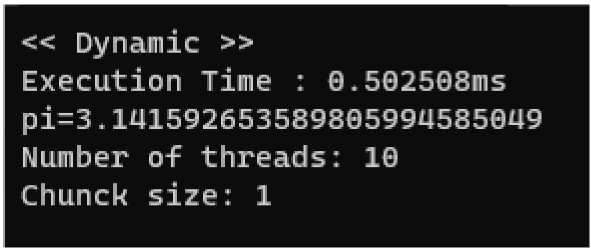


```
<< Static >>
Execution Time : 0.107101ms
pi=3.141592653589792227819544
Number of threads: 10
Chunck size: 1
```

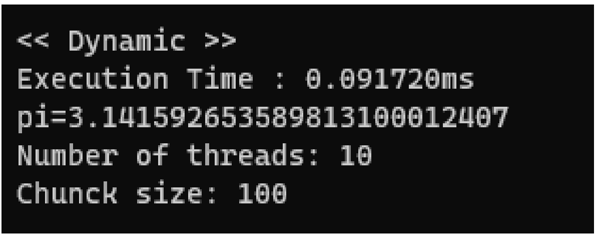


```
<< Static >>
Execution Time : 0.091134ms
pi=3.141592653589792227819544
Number of threads: 10
Chunck size: 100
```

In the case of dynamic scheduling, the performance improved as the chunk size increased. When the chunk size was 1, the performance was 1.87, and when the chunk size was increased to 100, it was confirmed that the performance increased to 11.87. This is because if the chunk size is small, there will be more thread switching. In addition, in the case of dynamic, it can be confirmed that the performance is worse than other scheduling types because even runtime overhead occurs.

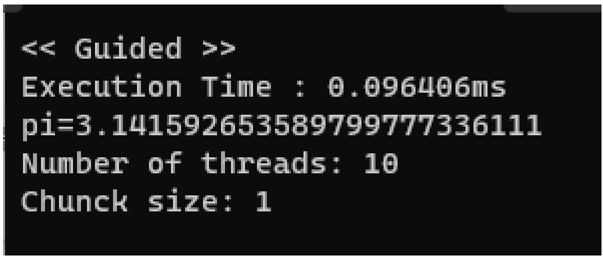


```
<< Dynamic >>
Execution Time : 0.502508ms
pi=3.141592653589805994585049
Number of threads: 10
Chunck size: 1
```

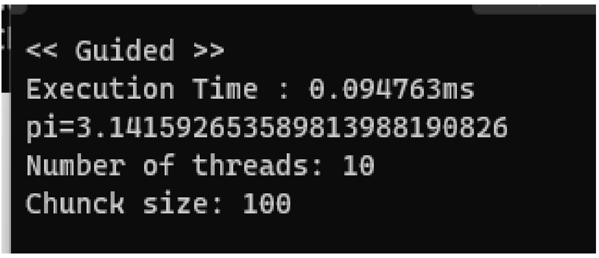


```
<< Dynamic >>
Execution Time : 0.091720ms
pi=3.141592653589813100012407
Number of threads: 10
Chunck size: 100
```

Guided scheduling performed the best among scheduling types. Guided allocates tasks if there is a valid thread like dynamic, but as the program progresses, each thread is assigned a task of a constant reduced chunk size. Since the chunk size decreases as the task is repeatedly assigned, it shows more effective performance.



```
<< Guided >>
Execution Time : 0.096406ms
pi=3.14159265358979977336111
Number of threads: 10
Chunck size: 1
```



```
<< Guided >>
Execution Time : 0.094763ms
pi=3.14159265358981398819O826
Number of threads: 10
Chunck size: 100
```