Home Assignment 5

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Question 5.2

The outputs are in Appendix A

To calculate the integration of $f(x) = x^2$ in the range $[0, 10]$.

```
For 4 threads, n equals (8, 800, 80000, 8000000, 800000000), the result
    are all 3.33e2.
For n = 800000000, number of thread equals (1, 4, 16, 32), , the result
    are all 3.33e2.
```

An error happened once with the following:

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 8000000000
With n = -589934592 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = -2.33076686576128e-06
```

This may caused by the fact that the value global_resul_p is not protected by #pragma omp critical. When we execute the code:

```
*global_result_p += my_result;
```

The adding operation may not be done serially. And if two adding happened at the same time, the slower one my overwrite the faster one's result.

Question 5.3

The outputs are in Appendix B

The output of the "omptrap1.c":

```
One thread is 15.36s
Two thread is 15.36s
```

The output of the "omptrap2a.c":

```
One thread is 15.36s
Two thread is 8.18s
```

for "omp_trap_1.c" with the first block of code in page 222. Because the global_result and trap() are both not private. So the thread are executed serially, and the time is not depend on the number of threads.

for "omp_trap_2a.c". Because the trap() is private. So the thread are executed paralleled, and the time is depend on the number of threads.

Question 5.4

identity value for:

```
&& is true
|| is false
& is 0000 0000
| is 1111 1111
^ is 0000 0000
```

Question 5.5

5.5.a

For each loop

```
sum = 0.0
register = 0.0 + 4.0 = 4.0
sum = 0.4e1
register = 4.0 + 3.0 = 7.0
sum = 0.7e1
register = 7.0 + 3.0 = 10.0
sum = 0.1e2
register = 10.0 + 1000.0 = 1010.0
sum = 0.101e4
```

Final output is $0.101e4$.

5.5.b

For thread 0:

```
sum = 0.0
register = 0.0 + 4.0 = 4.0
sum = 0.4e1
register = 4.0 + 3.0 = 7.0
sum = 0.7e1
```

For thread 1:

```
sum = 0.0
register = 0.0 + 3.0 = 3.0
sum = 0.3e1
register = 3.0 + 1000.0 = 1003.0
sum = 0.100e4 (rounded from 0.1003e4 to 0.100e4)
```

For final merge:

```
register = sum_thread0 + sum_thread1 = 7 + 1000 = 1007
sum = 0.1e4 (rounded from 0.1007e4 to 0.100e4) (if rounded using floor()
    )
sum = 0.101e4 (rounded from 0.1007e4 to 0.101e4) (if rounded using
    round() )
```

Final output is $0.1e4$. if we round the float variable using floor().
Final output is $0.101e4$. if we round the float variable using round().

Question 5.8

Original code:

```
a[0] = 0;
for (i = 1; i < n; i++)
    a[i] = a[i-1] + i;
```

Modified code:

```
a[0] = 0;
sum = 0;
for (i = 1; i < n; i++){
    sum += i;
    a[i] = sum;
}
```

Question 5.9

The outputs are in Appendix C for $a = 0, b = 10, n = 40, n\_thread = 4$

```
schedule(runtime) without OMP_SCHEDULE:
i for thread 0: 3, 12, 13, 14, 15, 16, 17, 18, 22, 23, 24, 25, 26, 27
i for thread 1: 1, 29
i for thread 2: 2, 5, 6, 7, 8, 9, 10, 11, 28
i for thread 3: 4, 19, 21, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39
```

```
schedule(runtime) with OMP_SCHEDULE = 4:
i for thread 0: 1, 2, 3, 4, 17, 18, 19, 20, 33, 34, 35, 36
i for thread 1: 5, 6, 7, 8, 21, 22, 23, 24, 37, 38, 39
i for thread 2: 9, 10, 11, 12, 25, 26, 27, 28,
i for thread 3:13, 14, 15, 16, 29, 30, 31, 32,

schedule(guided):
i for thread 0: 11, 12, 13, 14, 15, 16, 17, 18, 29, 30, 31
i for thread 1: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
i for thread 2: 19, 20, 21, 22, 23, 24, 34, 35, 36, 37, 38, 39
i for thread 3: 25, 26, 27, 28, 32, 33
```

My conclusion is that

- for schedule(static, n), the array are cut into block with size of n, and then be distributed to each threads in order.
- for schedule(runtime) without OMP_SCHEDULE and schedule(guided) the elements in the array are randomly distributed to each threads.

Appendix A

normal output (with critical directive):

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 800000000
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333326e+02
```

output (without critical directive):

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 1
Enter a, b, and n
0 10 800000000
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333305e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 16
Enter a, b, and n
0 10 800000000
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333336e+02
```

!!!!!!!!!!!!!!!!!!!!!!!!!!!!

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 8000000000
With n = -589934592 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = -2.33076686576128e-06
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 800000000
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333326e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 16
Enter a, b, and n
0 10 800000000
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333336e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 32
Enter a, b, and n
0 10 800000000
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333336e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 8
With n = 8 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.35937500000000e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 800
With n = 800 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333593750000e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 80000
With n = 80000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333359374e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 8000000
With n = 8000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333323e+02
```

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.2$
    ./run 4
Enter a, b, and n
0 10 800000000
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333326e+02
```

Appendix B

For the "omp_trap_1.c":

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.3$
    ./run 1
Enter a, b, and n
0 10 800000000
runtime = 15.295906
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333305e+02
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.3$
    ./run 2
Enter a, b, and n
0 10 800000000
runtime = 15.360965
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333327e+02
```

For the "omp_trap_2a.c":

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.3$
    ./run 1
Enter a, b, and n
```

```
0 10 800000000
runtime = 15.365113
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333305e+02
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.3$
    ./run 2
Enter a, b, and n
0 10 800000000
runtime = 8.179610
With n = 800000000 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33333333333327e+02
```

Appendix C

No export OMP_SCHEDULE

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.9$
    ./run 4
Enter a, b, and n
0 10 40
i = 2, thread = 2.
i = 5, thread = 2.
i = 6, thread = 2.
i = 7, thread = 2.
i = 8, thread = 2.
i = 9, thread = 2.
i = 10, thread = 2.
i = 3, thread = 0.
i = 12, thread = 0.
i = 13, thread = 0.
i = 14, thread = 0.
i = 15, thread = 0.
i = 16, thread = 0.
i = 17, thread = 0.
i = 4, thread = 3.
i = 19, thread = 3.
i = 20, thread = 3.
i = 18, thread = 0.
i = 22, thread = 0.
i = 23, thread = 0.
i = 24, thread = 0.
i = 25, thread = 0.
i = 26, thread = 0.
i = 11, thread = 2.
i = 1, thread = 1.
i = 21, thread = 3.
i = 30, thread = 3.
i = 31, thread = 3.
```

```
i = 32, thread = 3.
i = 33, thread = 3.
i = 34, thread = 3.
i = 35, thread = 3.
i = 36, thread = 3.
i = 37, thread = 3.
i = 38, thread = 3.
i = 39, thread = 3.
i = 27, thread = 0.
i = 28, thread = 2.
i = 29, thread = 1.
With n = 40 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33437500000000e+02
```

---

export OMP_SCHEDULE="static,4"

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.9$
    ./run 4
Enter a, b, and n
0 10 40
i = 1, thread = 0.
i = 2, thread = 0.
i = 3, thread = 0.
i = 4, thread = 0.
i = 17, thread = 0.
i = 18, thread = 0.
i = 19, thread = 0.
i = 20, thread = 0.
i = 33, thread = 0.
i = 34, thread = 0.
i = 35, thread = 0.
i = 36, thread = 0.
i = 5, thread = 1.
i = 6, thread = 1.
i = 7, thread = 1.
i = 8, thread = 1.
i = 21, thread = 1.
i = 22, thread = 1.
i = 23, thread = 1.
i = 24, thread = 1.
i = 37, thread = 1.
i = 38, thread = 1.
i = 39, thread = 1.
i = 9, thread = 2.
i = 10, thread = 2.
i = 11, thread = 2.
i = 12, thread = 2.
i = 25, thread = 2.
i = 26, thread = 2.
i = 27, thread = 2.
```

```
i = 28, thread = 2.
i = 13, thread = 3.
i = 14, thread = 3.
i = 15, thread = 3.
i = 16, thread = 3.
i = 29, thread = 3.
i = 30, thread = 3.
i = 31, thread = 3.
i = 32, thread = 3.
With n = 40 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33437500000000e+02
```

---

with schedule(guided)

```
yuxuan@yuxuan-XPS-13-9380:~/Dropbox/     k     /HPC/Assignments/Ex5/5.9$
    ./run 4
Enter a, b, and n
0 10 40
i = 11, thread = 0.
i = 12, thread = 0.
i = 13, thread = 0.
i = 14, thread = 0.
i = 15, thread = 0.
i = 16, thread = 0.
i = 17, thread = 0.
i = 18, thread = 0.
i = 29, thread = 0.
i = 30, thread = 0.
i = 25, thread = 3.
i = 26, thread = 3.
i = 27, thread = 3.
i = 28, thread = 3.
i = 32, thread = 3.
i = 19, thread = 2.
i = 20, thread = 2.
i = 21, thread = 2.
i = 22, thread = 2.
i = 23, thread = 2.
i = 24, thread = 2.
i = 34, thread = 2.
i = 35, thread = 2.
i = 36, thread = 2.
i = 37, thread = 2.
i = 38, thread = 2.
i = 39, thread = 2.
i = 33, thread = 3.
i = 1, thread = 1.
i = 31, thread = 0.
i = 2, thread = 1.
i = 3, thread = 1.
```

```
i = 4, thread = 1.
i = 5, thread = 1.
i = 6, thread = 1.
i = 7, thread = 1.
i = 8, thread = 1.
i = 9, thread = 1.
i = 10, thread = 1.
With n = 40 trapezoids, our estimate
of the integral from 0.000000 to 10.000000 = 3.33437500000000e+02
```