README.txt Page 1

```
//
//
         FEDERAL UNIVERSITY OF RIO GRANDE DO NORTE - UFRN
                                                     //
              DIGITAL METROPOLIS INSTITUTE - IMD
//
                                                     //
//
            BACHELOR OF INFORMATION TECHNOLOGY - BTI
//
         SPECIAL TOPICS ON INTERNET OF THINGS "B" - IMD0291
                                                     //
//
// Names: integral.h
                                                     //
//
                                                     //
      report.h
//
                                                     //
       report.pdf
//
       integral-by-trapezoid-rule-serial.cpp
//
       integral-by-trapezoid-rule-parallel.cpp
//
       calculates-serie-parallel-analysis.cpp
       shellscript_start.sh
//
                                                     11
//
       README.txt
                                                     //
// Date: 14/10/2020
                                                     //
// Version: 1.0
//
                                                     //
// Author: P.R.O.Lima
                                                     //
//
                                                     //
// Repository: https://github.com/r4m0nl1m4/integral-by-trapezoid-rule
//
// Software: GNU Compiler Collection (gcc) 9.3.0
                                                     11
//
^{\prime\prime} Description: Approximating the definite integral by trapezoid rule by
                                                     //
// serial and parallel computing.
//
// To execute:
                                                     //
//
    ~$ bash shellscript_start.sh
                                                     //
//
```

```
/*
 * CPU Report
 */
```

model name : Intel(R) Core(TM) i7-4770K CPU @ 3.50GHz vendor\_id : GenuineIntel cpu cores : 4 siblings : 8 cache size : 8192 KB

```
/*
* Serie Runtime Report In Seconds
   10000
               :4.10e-05:1.24e-04:1.13e-04:8.80e-05:1.43e-04
   20000
               :2.82e-04:1.35e-04:1.58e-04:2.26e-04:1.86e-04
   10000
               :1.05e-04:1.13e-04:1.31e-04:1.13e-04:7.20e-05
   20000
               :1.67e-04:2.10e-04:3.58e-04:1.66e-04:2.43e-04
               :4.30e-05:7.10e-05:7.50e-05:1.22e-04:7.60e-05
   10000
               :1.58e-04:3.49e-04:1.58e-04:1.59e-04:1.43e-04
   20000
              :8.30e-05:7.20e-05:1.13e-04:7.50e-05:6.80e-05
   10000
              :1.37e-04:1.99e-04:1.66e-04:1.43e-04:1.67e-04
   20000
```

```
* Parallel Runtime Report In Seconds
2 10000
                  :4.29e-05:1.65e-04:3.43e-05:6.70e-05:3.98e-05
2 20000
                  :5.77e-05:6.27e-05:8.00e-05:7.64e-05:1.04e-04
4 10000
                  :4.28e-05:5.81e-05:6.00e-05:3.06e-05:4.83e-05
4 20000
                 :9.09e-05:6.95e-05:4.45e-05:9.57e-05:9.03e-05
                 :1.13e-04:1.59e-04:4.12e-05:5.11e-05:6.44e-05
:1.52e-04:3.95e-05:1.23e-04:1.95e-04:1.14e-04
6 10000
6 20000
               :1.52e-04:3.95e-05:1.23e-04:1.95e-04:1.14e-04
:6.50e-05:6.97e-05:1.22e-04:5.38e-05:1.86e-04
:9.92e-05:2.17e-04:6.02e-05:2.29e-04:1.53e-04
8 10000
8 20000
                 :9.92e-05:2.17e-04:6.02e-05:2.29e-04:1.53e-04
```

```
* Speedup Report
2 10000
               :9.56e-01:7.52e-01:3.29e+00:1.31e+00:3.59e+00
2 20000
               :4.89e+00:2.15e+00:1.97e+00:2.96e+00:1.79e+00
               :2.45e+00:1.94e+00:2.18e+00:3.69e+00:1.49e+00
4 10000
4 20000
               :1.84e+00:3.02e+00:8.04e+00:1.73e+00:2.69e+00
               :3.81e-01:4.47e-01:1.82e+00:2.39e+00:1.18e+00
:1.04e+00:8.84e+00:1.28e+00:8.15e-01:1.25e+00
6 10000
6 20000
              :1.28e+00:1.03e+00:9.26e-01:1.39e+00:3.66e-01
8 10000
8 20000
              :1.38e+00:9.17e-01:2.76e+00:6.24e-01:1.09e+00
```

/* * Parallel Calc */	culation R	deport			
2 Cores CPU - S	Size Probl	em 10000			
Try 1					
Runtime 4.29	e-05 [s]				
Process 0 1	Total 2 2	problemSize 5000 5000	Total 10000 10000	Local 1.458333 1.208333	1.458333
Try 2					
Runtime 1.65	Se-04 [s]				
Process 0 1		problemSize 5000 5000	Total 10000 10000	Local 1.458333 1.208333	Total 1.458333 2.666667
Try 3					
Runtime 3.43	Be-05 [s]				
Process 0 1	Total 2 2	problemSize 5000 5000		Local 1.458333 1.208333	Total 1.458333 2.666667
Try 4					
Runtime 6.70	e-05 [s]				
Process 0 1	Total 2 2	problemSize 5000 5000	Total 10000 10000	Local 1.458333 1.208333	
Try 5					
Runtime 3.98	Be-05 [s]				
Process 0 1		problemSize 5000 5000	Total 10000 10000	Local 1.458333 1.208333	Total 1.458333 2.666667
2 Cores CPU - S	Size Probl	em 20000			
Try 1					
Runtime 5.77	/e-05 [s]				
Process 0 1	Total 2 2	problemSize 10000 10000	Total 20000 20000	Local 1.458333 1.208333	Total 1.458333 2.666667
Try 2					
Runtime 6.27e-05 [s]					
Process 0 1	Total 2 2	problemSize 10000 10000	Total 20000 20000	Local 1.458333 1.208333	Total 1.458333 2.666667
Try 3					
Runtime 8.00	e-05 [s]				
Process 0 1	Total 2 2	problemSize 10000 10000	Total 20000 20000	Local 1.458333 1.208333	Total 1.458333 2.666667

Try 4					
Runtime 7.64e-05	[s]				
Process T 0 1	otal 2 2	problemSize 10000 10000	Total 20000 20000	Local 1.458333 1.208333	Total 1.458333 2.666667
Try 5					
Runtime 1.04e-04	[s]				
Process T 0 1	otal 2 2	problemSize 10000 10000	Total 20000 20000	Local 1.458333 1.208333	Total 1.458333 2.666667
4 Cores CPU - Size	Probl	em 10000			
Try 1					
Runtime 4.28e-05	[s]				
Process T 0 1 2 3	otal 4 4 4 4	problemSize 2500 2500 2500 2500	Total 10000 10000 10000 10000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 2					
Runtime 5.81e-05	[s]				
Process T 0 1 2 3	otal 4 4 4 4	problemSize 2500 2500 2500 2500	Total 10000 10000 10000 10000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 3					
Runtime 6.00e-05	[s]				
Process T 0 1 2 3	otal 4 4 4 4	problemSize 2500 2500 2500 2500	Total 10000 10000 10000 10000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 4					
Runtime 3.06e-05	[s]				
Process T 0 1 2 3	otal 4 4 4 4	problemSize 2500 2500 2500 2500	Total 10000 10000 10000 10000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 5					
Runtime 4.83e-05	[s]				
Process T 0 1 2 3	otal 4 4 4 4	problemSize 2500 2500 2500 2500	Total 10000 10000 10000 10000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667

<sup>4</sup> Cores CPU - Size Problem 20000

	-				
Try 1					
Runtime 9.09e	e-05 [s]				
Process 0 1 2 3	Total 4 4 4 4	problemSize 5000 5000 5000 5000	Total 20000 20000 20000 20000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 2					
Runtime 6.95e	e-05 [s]				
Process 0 1 2 3	Total 4 4 4 4	problemSize 5000 5000 5000 5000	Total 20000 20000 20000 20000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 3					
Runtime 4.45e	e-05 [s]				
Process 0 1 2 3	Total 4 4 4 4	problemSize 5000 5000 5000 5000	Total 20000 20000 20000 20000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 4					
Runtime 9.57e	e-05 [s]				
Process 0 1 2 3	Total 4 4 4 4	problemSize 5000 5000 5000 5000	Total 20000 20000 20000 20000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
Try 5					
Runtime 9.03e	e-05 [s]				
Process 0 1 2 3	Total 4 4 4 4	problemSize 5000 5000 5000 5000	Total 20000 20000 20000 20000	Local 0.744792 0.713542 0.651042 0.557292	Total 0.744792 1.458333 2.109375 2.666667
6 Cores CPU - Si	ze Probl	em 10000			
Try 1					
Runtime 1.13e	e-04 [s]				
Process 0 1 2 3 4 5	Total 6 6 6 6 6 6 6	problemSize 1666 1666 1666 1666 1666	Total 10000 10000 10000 10000 10000	Local 0.498259 0.489010 0.470514 0.442770 0.405777 0.359536	Total 0.498259 0.987269 1.457783 1.900553 2.306330 2.665867
Try 2					
Runtime 1.59e	e-04 [s]				
Process 0 1 2	Total 6 6 6	problemSize 1666 1666 1666	Total 10000 10000 10000	Local 0.498259 0.489010 0.470514	Total 0.498259 0.987269 1.457783

result_report-parallel-cpu.txt Page						
3 4 5	6 6 6	1666 1666 1666	10000 10000 10000	0.442770 0.405777 0.359536	1.900553 2.306330 2.665867	
Try 3						
Runtime 4	4.12e-05 [s]					
Process 0 1 2 3 4 5	Total 6 6 6 6 6	problemSize 1666 1666 1666 1666 1666	Total 10000 10000 10000 10000 10000	Local 0.498259 0.489010 0.470514 0.442770 0.405777 0.359536	Total 0.498259 0.987269 1.457783 1.900553 2.306330 2.665867	
Try 4						
Runtime 5	5.11e-05 [s]					
Process 0 1 2 3 4 5	Total 6 6 6 6 6	problemSize 1666 1666 1666 1666 1666	Total 10000 10000 10000 10000 10000	Local 0.498259 0.489010 0.470514 0.442770 0.405777 0.359536	Total 0.498259 0.987269 1.457783 1.900553 2.306330 2.665867	
Try 5						
Runtime 6	6.44e-05 [s]					
Process 0 1 2 3 4 5	Total 6 6 6 6 6	problemSize 1666 1666 1666 1666 1666	Total 10000 10000 10000 10000 10000	Local 0.498259 0.489010 0.470514 0.442770 0.405777 0.359536	Total 0.498259 0.987269 1.457783 1.900553 2.306330 2.665867	
6 Cores CPU	- Size Probl	em 20000				
Try 1						
Runtime 1	1.52e-04 [s]					
Process 0 1 2 3 4 5	Total 6 6 6 6 6 6	problemSize 3333 3333 3333 3333 3333 3333	Total 20000 20000 20000 20000 20000 20000	Local 0.498407 0.489151 0.470638 0.442868 0.405842 0.359560	Total 0.498407 0.987558 1.458196 1.901064 2.306907 2.666467	
Try 2						
Runtime 3.95e-05 [s]						
Process 0 1 2 3 4 5	Total 6 6 6 6 6 6	problemSize	Total 20000 20000 20000 20000 20000 20000	Local 0.498407 0.489151 0.470638 0.442868 0.405842 0.359560	Total 0.498407 0.987558 1.458196 1.901064 2.306907 2.666467	
Try 3						
Runtime 1	1.23e-04 [s]					
Process 0	Total 6	problemSize 3333	Total 20000	Local 0.498407	Total 0.498407	

result_report-p	arallel-cp	u.txt				Page 5
1 2 3 4 5	6 6 6 6	3333 3333 3333 3333 3333	20000 20000 20000 20000 20000	0.489151 0.470638 0.442868 0.405842 0.359560	0.987558 1.458196 1.901064 2.306907 2.6664467	
Try 4						
Runtime 1.9	5e-04 [s]					
Process 0 1 2 3 4 5	Total 6 6 6 6 6	problemSize 3333 3333 3333 3333 3333 3333	Total 20000 20000 20000 20000 20000 20000	Local 0.498407 0.489151 0.470638 0.442868 0.405842 0.359560	Total 0.498407 0.987558 1.458196 1.901064 2.306907 2.666467	
Try 5						
Runtime 1.1	4e-04 [s]					
Process 0 1 2 3 4 5	Total 6 6 6 6 6	problemSize	Total 20000 20000 20000 20000 20000 20000	Local 0.498407 0.489151 0.470638 0.442868 0.405842 0.359560	Total 0.498407 0.987558 1.458196 1.901064 2.306907 2.6666467	
8 Cores CPU -	Size Probl	em 10000				
Try 1	Size liobi	em 10000				
Runtime 6.5	0e-05 [s]					
Process	Total	problemSize	Total	Local	Total	
0 1 2 3 4 5 6 7	8 8 8 8 8 8	1250 1250 1250 1250 1250 1250 1250 1250	10000 10000 10000 10000 10000 10000 10000	0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.666667	
Try 2						
Runtime 6.9	7e-05 [s]					
Process 0 1 2 3 4 5 6	Total 8 8 8 8 8 8 8	problemSize 1250 1250 1250 1250 1250 1250 1250	Total 10000 10000 10000 10000 10000 10000 10000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.6666667	
Try 3						
Runtime 1.2	2e-04 [s]					
Process 0 1 2 3 4 5 6	Total 8 8 8 8 8 8	problemSize 1250 1250 1250 1250 1250 1250 1250	Total 10000 10000 10000 10000 10000 10000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693	

resurc_report-pa	rarrer-cp	u. cxc			ra
7	8	1250	10000	0.264974	2.666667
Try 4					
Runtime 5.38	8e-05 [s]				
Process 0 1 2 3 4 5 6 7	Total 8 8 8 8 8 8	problemSize 1250 1250 1250 1250 1250 1250 1250 1250	Total 10000 10000 10000 10000 10000 10000 10000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.6666667
Try 5					
Runtime 1.80	6e-04 [s]				
Process 0 1 2 3 4 5 6 7	Total 8 8 8 8 8 8 8	problemSize 1250 1250 1250 1250 1250 1250 1250 1250	Total 10000 10000 10000 10000 10000 10000 10000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.666667
8 Cores CPU - S	Size Probl	em 20000			
Try 1					
Runtime 9.92	2e-05 [s]				
Process 0 1 2 3 4 5 6	Total 8 8 8 8 8 8 8	problemSize 2500 2500 2500 2500 2500 2500 2500 2500 2500	Total 20000 20000 20000 20000 20000 20000 20000 20000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.666667
Try 2					
Runtime 2.1	7e-04 [s]				
Process 0 1 2 3 4 5 6	Total 8 8 8 8 8 8	2500 2500 2500 2500 2500 2500 2500 2500	Total 20000 20000 20000 20000 20000 20000 20000 20000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.6666667
Try 3					
Runtime 6.02	2e-05 [s]				
Process 0 1 2 3 4 5	Total 8 8 8 8 8 8	problemSize 2500 2500 2500 2500 2500 2500 2500	Total 20000 20000 20000 20000 20000 20000 20000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693

7	8	2500	20000	0.264974	2.666667
Try 4					
Runtime 2.29	e-04 [s]				
Process 0 1 2 3 4 5 6 7	Total 8 8 8 8 8 8 8	problemSize 2500 2500 2500 2500 2500 2500 2500 2500	Total 20000 20000 20000 20000 20000 20000 20000 20000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.666667
Try 5					
Runtime 1.53	Be-04 [s]				
Process 0 1 2 3 4 5 6 7	Total 8 8 8 8 8 8 8	problemSize 2500 2500 2500 2500 2500 2500 2500 2500	Total 20000 20000 20000 20000 20000 20000 20000 20000	Local 0.374349 0.370443 0.362630 0.350911 0.335286 0.315755 0.292318 0.264974	Total 0.374349 0.744792 1.107422 1.458333 1.793620 2.109375 2.401693 2.666667