

```
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////  
//  
//          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: oddeven.h  
//         report.h  
//         report.pdf  
//         odd-even-transposition-sort-serial.cpp  
//         odd-even-transposition-sort-parallel.cpp  
//         calculates-serie-parallel-analysis.cpp  
//         shellscript_start.sh  
//         README.txt  
// Date: 28/10/2020  
// Version: 1.0  
//  
// Author: P.R.O.Lima  
//  
// Repository: https://github.com/r4m0nllm4/odd-even-transposition-sort  
//  
// Software: GNU Compiler Collection (gcc) 9.3.0  
//  
/////////////////////////////////////////////////////////////////////////////////////////////////////////////////  
//  
// Description: Simple sorting algorithm, developed for use on serie and  
// parallel processors with local interconnections. It is a comparison  
// sort related to bubble sort, with which it shares many characteristics.  
// It functions by comparing all odd/even indexed pairs of adjacent  
// elements in the list and, if a pair is in the wrong order (the first is  
// larger than the second) the elements are switched. The next step  
// repeats this for even/odd indexed pairs (of adjacent elements). Then it  
// alternates between odd/even and even/odd steps until the list is  
// sorted.  
//  
/////////////////////////////////////////////////////////////////////////////////////////////////////////////////  
//  
// 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
```

```
/*  
 * Problem Size Report  
 */
```

```
:200:200:200:200:200  
:200:200:200:200:200  
:200:200:200:200:200
```

```
/*  
 * OddEven Transposition Sort using Serie Process Runtime Report In Seconds  
 */  
  
:1.05e-04:3.02e-04:3.98e-04:2.13e-04:3.51e-04  
:2.55e-04:2.69e-04:1.75e-04:3.84e-04:4.18e-04  
:2.00e-04:1.98e-04:2.02e-04:1.81e-04:1.88e-04
```

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

```
:2:2:2:2:2  
:4:4:4:4:4  
:8:8:8:8:8
```

```
/*
 * OddEven Transposition Sort using Parallel Process (MPI) Runtime Report In Seconds
 */

:8.15e-05:1.04e-04:7.39e-05:6.07e-05:8.11e-05
:7.65e-05:1.17e-04:7.49e-05:8.07e-05:1.83e-04
:2.85e-04:1.78e-04:2.24e-04:3.22e-04:2.86e-04
```

```
/*  
 * OddEven Transposition Sort using Parallel Process (MPI) Speedup Report  
 */  
  
:1.29:2.90:5.39:3.51:4.33  
:3.33:2.30:2.34:4.76:2.28  
:0.70:1.11:0.90:0.56:0.66
```

```
/*  
 * OddEven Transposition Sort using Parallel Process (MPI) Efficiency Report  
 */  
  
:0.65:1.45:2.69:1.75:2.17  
:0.83:0.57:0.58:1.19:0.57  
:0.09:0.14:0.11:0.07:0.08
```



```
/*  
 * Array Report  
 */
```

```
 7 21 27 82 91 71 41 64 33 49 76 31 48 23 68 46 72 67 84 40 31 93 83 95 1 82 62 61 6  
1 97 66 9 47 89 43 57 2 86 84 72 24 81 83 63 64 66 34 52 41 30 56 38 81 53 16 34 48  
99 47 55 57 57 72 89 32 40 64 39 17 49 2 11 86 17 83 92 25 16 34 8 86 17 65 36 19 13  
 73 44 6 11 83 2 79 88 35 21 39 28 74 40 76 67 51 29 68 64 40 29 54 27 67 63 18 52 2  
4 10 95 15 59 67 51 94 34 0 88 0 46 7 25 75 35 54 10 59 34 93 28 90 91 38 82 28 26 6  
3 35 29 65 25 13 73 70 19 46 76 70 62 75 68 34 29 4 23 63 70 31 23 74 14 0 51 73 52  
3 18 91 72 49 90 81 23 29 4 54 4 70 62 98 63 57 61 18 14 87 51 91 76 21 61 66 10
```

```
/*
 * OddEven Transposition Sort using Parallel Process (MPI) Calculation Report:
 * Ordered Array
 */

2 Cores CPU - Size Problem 200

Try 1

Runtime 8.15e-05 [s]

Ordered Array is:
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
-----

Try 2

Runtime 1.04e-04 [s]

Ordered Array is:
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
-----

Try 3

Runtime 7.39e-05 [s]

Ordered Array is:
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
-----

Try 4

Runtime 6.07e-05 [s]

Ordered Array is:
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
-----

Try 5

Runtime 8.11e-05 [s]

Ordered Array is:
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
```

```
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

4 Cores CPU - Size Problem 200

Try 1

Runtime 7.65e-05 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 2

Runtime 1.17e-04 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 3

Runtime 7.49e-05 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 4

Runtime 8.07e-05 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 5

Runtime 1.83e-04 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
```

```
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

8 Cores CPU - Size Problem 200

Try 1

Runtime 2.85e-04 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 2

Runtime 1.78e-04 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 3

Runtime 2.24e-04 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 4

Runtime 3.22e-04 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
6 47 47 48 48 49 49 49 51 51 51 51 52 52 52 53 54 54 54 55 56 57 57 57 57 59 59 61 6
1 61 61 62 62 62 63 63 63 63 63 64 64 64 64 65 65 66 66 66 67 67 67 67 68 68 68 70 7
0 70 70 71 72 72 72 72 73 73 73 74 74 75 75 76 76 76 76 79 81 81 81 82 82 82 83 83 8
3 83 84 84 86 86 86 87 88 88 89 89 90 90 91 91 91 91 92 93 93 94 95 95 97 98 99
```

Try 5

Runtime 2.86e-04 [s]

Ordered Array is:

```
0 0 0 1 2 2 2 3 4 4 4 6 7 7 8 9 10 10 10 11 11 13 13 14 14 15 16 16 17 17 17 18 18 1
8 19 19 21 21 21 23 23 23 23 24 24 25 25 25 26 27 27 28 28 28 29 29 29 29 30 31 3
1 31 32 33 34 34 34 34 34 34 35 35 35 36 38 38 39 39 40 40 40 40 41 41 43 44 46 46 4
```

6	47	47	48	48	49	49	49	51	51	51	51	52	52	52	53	54	54	54	55	56	57	57	57	57	59	59	61	6
1	61	61	62	62	62	63	63	63	63	63	64	64	64	64	65	65	66	66	66	67	67	67	67	68	68	68	70	7
0	70	70	71	72	72	72	72	73	73	73	74	74	75	75	76	76	76	76	79	81	81	81	82	82	82	83	83	8
3	83	84	84	86	86	86	87	88	88	89	89	90	90	91	91	91	91	92	93	93	94	95	95	97	98	99		
