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Program Structures & Algorithms

Fall 2021

Assignment No. 2

Task (List down the tasks performed in the Assignment)

1. Complete the implementation of Timer.java
2. Implement Insertion Sort
3. Implement a main program to measure the running times of Insertion Sort, using four different initial array ordering situations
4. Make a conclusion of the order of growth in different situation

Relationship Conclusion:

- **Order of growth in 4 different situation:**
Inverse > Random > partially ordered > ordered
- **In particular:**
The growth of “Ordered array” is nearly linear.

Evidence to support the conclusion:

1. Output

The running time of 6 size of insertion sort in 4 different situations are shown below, each test was run 10 times.

```
=====Sort time(ms) when n = 1000 =====
random array:      3.7804 ms
ordered array:     0.0080 ms
partially-ordered: 0.1482 ms
inverse array:     2.5945 ms

=====Sort time(ms) when n = 2000 =====
random array:      6.2933 ms
ordered array:     0.0221 ms
partially-ordered: 0.4953 ms
inverse array:     11.2133 ms

=====Sort time(ms) when n = 4000 =====
random array:     22.0400 ms
ordered array:     0.0265 ms
partially-ordered: 2.1481 ms
inverse array:     40.5606 ms

=====Sort time(ms) when n = 8000 =====
random array:     83.1732 ms
ordered array:     0.0421 ms
partially-ordered: 7.8354 ms
inverse array:    164.3221 ms

=====Sort time(ms) when n = 16000 =====
random array:    330.6761 ms
ordered array:     0.0810 ms
partially-ordered: 34.9747 ms
inverse array:    643.3314 ms

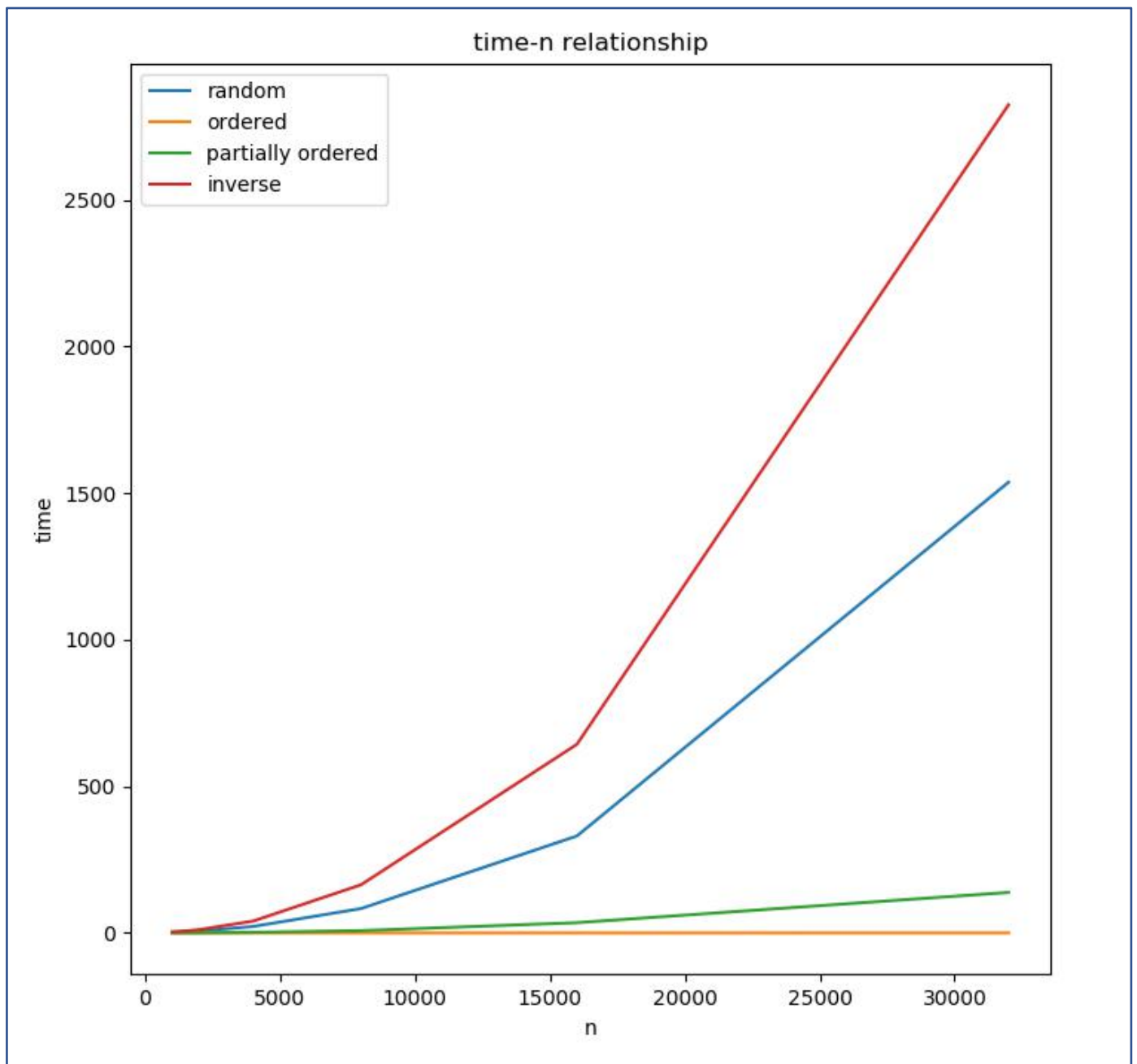
=====Sort time(ms) when n = 32000 =====
random array:   1537.1798 ms
ordered array:     0.1610 ms
partially-ordered: 138.1176 ms
inverse array:   2824.3726 ms
```

2. Graphical Representation

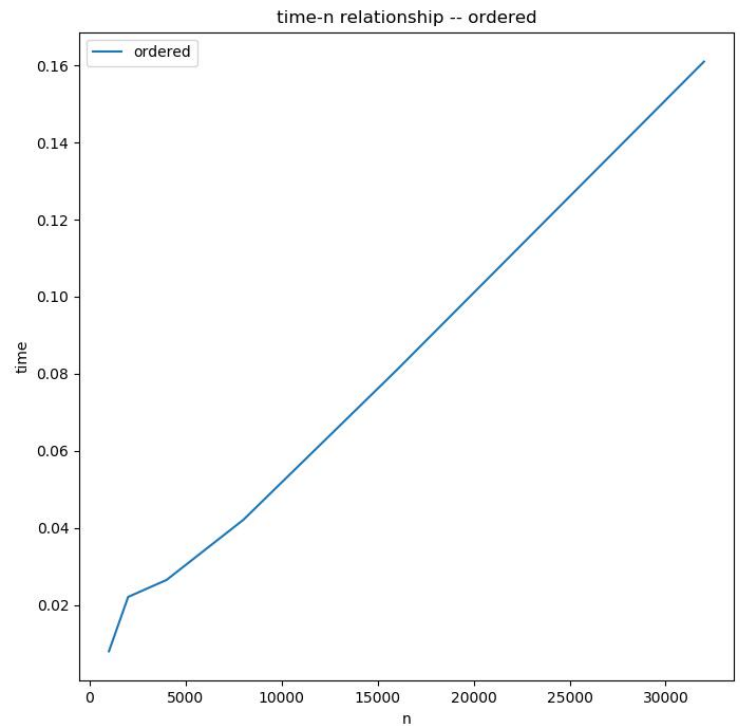
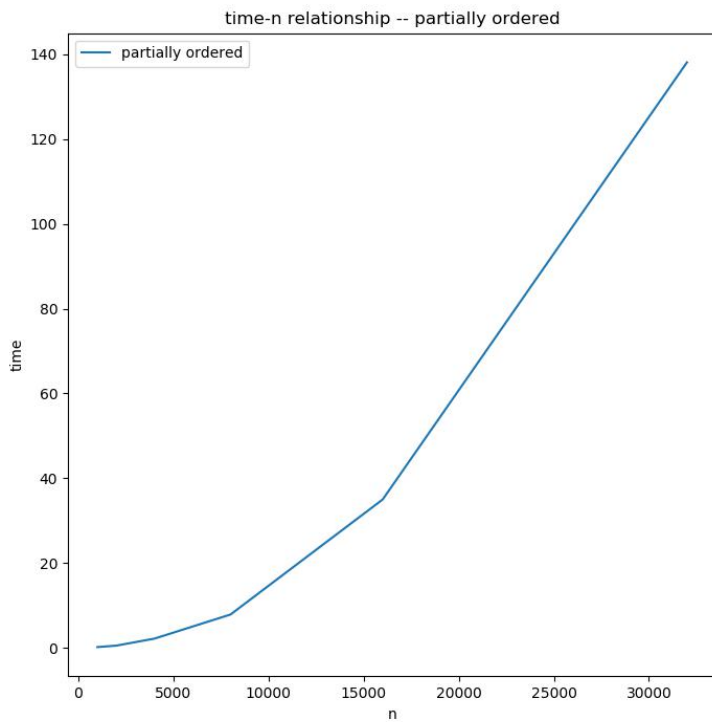
(1) Use Python to plot the sorting time of different situations in single graph

It is obvious that the order growth rate is:

Inverse > Random > partially ordered > ordered



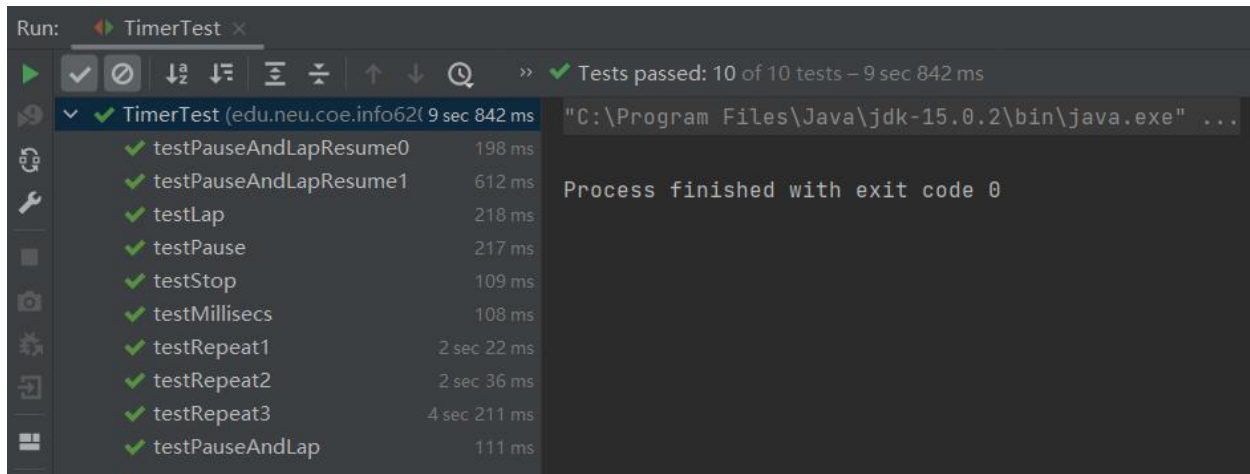
(2) In particular, I plot the growth of partially ordered and ordered in another graph, because they are inapparent when compared to the others



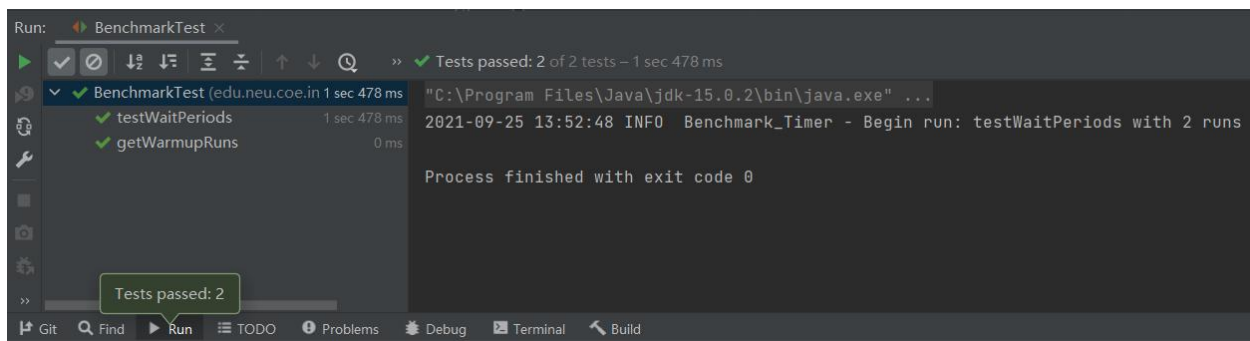
The growth of “Partially ordered” is still n -squared, while the “ordered” growth is linear.

Unit tests result:

1. TimerTest



2. BenchmarkTest



3. InsertionSortTest

