ANALYSIS

1-SELECTION SORT

SS) Analysis for SelectionSort on a Sorted Array:

- n min: 7,500
- t min: 37 ms
- n max: 1,000,000
- t max: 705,559 ms

1. Empirical Ratio:

Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 705559 / 37 ≈ ***19,078***

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

  Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 1000000 / 7500 ≈ 133.33

- Log-Linear Complexity (O (n \log n)):

  Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})}$ = 1000000·log (1000000)/ 7500·log(7500) ≈ 455.42

- Quadratic Complexity (O(n^2)):

  Quadratic Ratio = $\frac{\text{n max}^\wedge 2}{\text{n min}^\wedge 2}$ = $1000000^2 / 7500^2$ ≈ 17777.783.

3. Comparison:

- The empirical ratio is approximately 19,078, which is closest to the quadratic ratio of 17,777.78.
- This suggests that SelectionSort on a sorted array behaves as expected, with quadratic complexity $O(n^2)$, which aligns with the known time complexity of SelectionSort.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
ss	***19,078***	133.33	455.42	17777.783	$O(n^2)$

SC) Analysis for SelectionSort on a Constant Array:

- n min: 7,500
- t min: 37 ms
- n max: 1,000,000
- t max: 694,690 ms

1. Empirical Ratio:

Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 694690 / 37 ≈ **18,770**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

  Linear Ratio = $\frac{\text{n max}}{\text{n min}} = 1000000\ /\ 7500$ ≈ 133.33

- Log-Linear Complexity (O (n \log n)):

  Log-Linear Ratio= $\frac{\text{n max} \cdot \log\text{(n max)}}{\text{n min} \cdot \log\text{(n min)}} = \frac{1000000 \cdot \log(1000000)}{7500 \cdot log(7500)}$ ≈ 455.42

- Quadratic Complexity (O(n^2)):

  Quadratic Ratio = $\frac{\text{n max\^{}2}}{\text{n min\^{}2}}$ = $1000000^2 / 7500^2$ ≈ 17,777.78

3. Comparison:

- The empirical ratio is approximately 18,770, which again closely matches the quadratic ratio of 17,777.78.
- This confirms that SelectionSort on a constant array also behaves with quadratic complexity $O(n^2)$, as expected.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
ss	**19,078**	133.33	455.42	17777.783	$O(n^2)$
sc	**18,770**	133.33	455.42	17,777.78	$O(n^2)$

SR) Analysis for SelectionSort on a Random Array:

- n min: 7,500
- t min: 37 ms
- n max: 1,000,000
- t max: 713,504 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 713504 / 37 ≈ **19,277**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 1000000 / 7500 ≈ 133.33

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})} = \frac{1000000 \cdot \log(1000000)}{7500 \cdot \log(7500)}$ ≈ 455.42

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max}\text{\^{}}2}{\text{n min}\text{\^{}}2}$ = $1000000^2 / 7500^2$ ≈ 17,777.78

3. Comparison:

- The empirical ratio is approximately 19,277, which is very close to the quadratic ratio of 17,777.78.
- This confirms that SelectionSort on a random array behaves with quadratic complexity $O(n^2)$, which is in line with theoretical expectations for SelectionSort.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$

2-INSERTION SORT

IS) Analysis for InsertionSort on a Sorted Array:

- n min: 13,000,000
- t min: 30 ms
- n max: 200,000,000
- t max: 472 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 472 / 30 ≈ **15.73**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 200000000 / 13000000 ≈ 15.38

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})} = \frac{200000000 \cdot \log(200000000)}{13000000 \cdot \log(13000000)}$ ≈ 205.72

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max}\char`^2}{\text{n min}\char`^2}$ = $200000000^2 / 13000000^2$ ≈236.25

3. Comparison:

- The empirical ratio is 15.73, which is very close to the linear ratio of 15.38.
- This indicates that InsertionSort on a sorted array behaves with linear complexity O(n), which is expected because InsertionSort has a best-case complexity of O(n) for already sorted arrays.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)

IC) Analysis for InsertionSort on a Constant Array:

- n min: 15,000,000
- t min: 35 ms
- n max: 200,000,000
- t max: 463 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 463 / 35 ≈ **13.23**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 200000000 / 15000000 ≈ 13.33

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})} = \frac{200000000 \cdot \log(200000000)}{15000000 \cdot \log(15000000)}$ ≈ 176.18

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max^2}}{\text{n min^2}}$ = 200000000^2 / 15000000^2 ≈ 177.78

3. Comparison:

- The empirical ratio is 13.23, which is almost identical to the linear ratio of 13.33.
- This shows that InsertionSort on a constant array behaves with linear complexity O(n), which makes sense because for constant arrays, the algorithm will encounter minimal shifting, behaving as it does for sorted arrays in the best-case scenario.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)

IR) Analysis for InsertionSort on a Random Array:

- n min: 9,000
- t min: 34 ms
- n max: 1,000,000
- t max: 452,128 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 452128 / 34 ≈ **13,290.59**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 1000000 / 9000 ≈ 111.11

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})} = \frac{1000000 \cdot log(1000000)}{9000 \cdot log(9000)}$ ≈ 1,168.12

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max\^{}2}}{\text{n min\^{}2}}$ = $1000000^2 / 9000^2$ ≈ 123,456.79

3. Comparison:

- The empirical ratio is approximately 13,290.59, which is significantly higher than the linear ratio of 111.11.
- The empirical ratio is also far from the log-linear ratio and much less than the quadratic ratio of 123,456.79.
- This suggests that InsertionSort on a random array exhibits characteristics closer to quadratic complexity $O(n^2)$ in practice. This aligns with expectations since InsertionSort has an average-case complexity of $O(n^2)$.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	$O(n^2)$

3-MERGE SORT

MS) Analysis for MergeSort on a Sorted Array:

- n min: 700,000
- t min: 36 ms
- n max: 200,000,000
- t max: 14,821 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 14821/36 ≈ **411.69**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 200000000 / 700000 ≈ 285.71

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})} = \frac{200000000 \cdot log(200000000)}{700000 \cdot log(700000)}$ ≈ 1,777.78

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max\^{}2}}{\text{n min\^{}2}}$ = 200000000^2 / 700000^2 ≈ 81,632.65

3. Comparison:

- The empirical ratio is approximately 411.69, which is closest to the linear ratio of 285.71.
- This suggests that MergeSort on a sorted array behaves with log-linear complexity O(n logn), which is expected given the nature of MergeSort.
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	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	$O(n^2)$
MS	**411.69**	285.71	1,777.78	81,632.65	O(n logn)

MC) Analysis for MergeSort on a Constant Array:

- n min: 700,000
- t min: 36 ms
- n max: 200,000,000
- t max: 14,935 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 14935 / 36 ≈ **414.86**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 200000000 / 700000 ≈ 285.71

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})} = \frac{200000000 \cdot log(200000000)}{700000 \cdot log(700000)}$ ≈ 1,777.78

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max\^{}2}}{\text{n min\^{}2}}$ = 200000000^2 / 700000^2 ≈ 81,632.65

3. Comparison:

- The empirical ratio is approximately 414.86, which is closest to the linear ratio of 285.71.
- This indicates that MergeSort on a constant array behaves with log-linear complexity O(n logn), as expected for MergeSort.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	$O(n^2)$
MS	**411.69**	285.71	1,777.78	81,632.65	O(n logn)
MC	**414.86**	285.71	1,777.78	81,632.65	O(n logn)

MR) Analysis for MergeSort on a Random Array:

- n min: 300,000
- t min: 33 ms
- n max: 200,000,000
- t max: 27,725 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 27725 / 33 ≈ **840.15**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 200000000 / 300000 ≈ 666.67

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log\text{(n max)}}{\text{n min} \cdot \log\text{(n min)}} = \frac{200000000 \cdot log(200000000)}{300000 \cdot log(300000)}$ ≈ 3,188.39

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max^2}}{\text{n min^2}}$ = $200000000^2 / 300000^2$ ≈ 444,444.44

3. Comparison:

- The empirical ratio is approximately 840.15, which is closer to the linear ratio of 666.67.
- This indicates that MergeSort on a random array exhibits characteristics of log-linear complexity O(n logn) as expected, but it also suggests a bit more overhead due to the randomness in the input.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	$O(n^2)$
MS	**411.69**	285.71	1,777.78	81,632.65	O (n logn)
MC	**414.86**	285.71	1,777.78	81,632.65	O (n logn)
MR	**840.15**	666.67	3,188.39	444,444.44	O (n logn)

4-QUICK SORT

QS) Analysis for QuickSort on a Sorted Array:

- n min: 500,000
- t min: 32 ms
- n max: 200,000,000
- t max: 405,087 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 405087 / 32 ≈ **12,660.22**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 200000000 / 500000 = 400

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log\text{(n max)}}{\text{n min} \cdot \log\text{(n min)}} = \frac{200000000 \cdot log(200000000)}{500000 \cdot log(500000)}$ ≈ 2,988.93

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max\^{}2}}{\text{n min\^{}2}}$ = 200000000^2 / 500000^2 = 1600

3. Comparison:

- The empirical ratio is approximately 12,660.22, which is significantly higher than both the linear ratio of 400 and the log-linear ratio of 2,988.93.
- This suggests that QuickSort on a sorted array behaves closer to quadratic complexity $O(n^2)$ due to the nature of its pivot selection, especially when the array is already sorted (as it can lead to unbalanced partitions).

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	$O(n^2)$
MS	**411.69**	285.71	1,777.78	81,632.65	O (n logn)
MC	**414.86**	285.71	1,777.78	81,632.65	O (n logn)
MR	**840.15**	666.67	3,188.39	444,444.44	O (n logn)
QS	**12,660.22**	400	2,988.93	1600	$O(n^2)$

QC) Analysis for QuickSort on a Constant Array:

- n min: 7,500
- t min: 34 ms
- n max: 1,000,000
- t max: 653,506 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 653506 / 34 ≈ **19,194.24**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ = 1000000 / 7500 ≈ 133.33

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log\text{(n max)}}{\text{n min} \cdot \log\text{(n min)}} = \frac{1000000 \cdot \log(1000000)}{7500 \cdot \log(7500)}$ ≈ 455.42

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max\^{}2}}{\text{n min\^{}2}}$ = $1000000^2 / 7500^2$ ≈ 17777.78

3. Comparison:

- The empirical ratio is approximately 19,194.24, which is closest to the quadratic ratio of 17,777.78.
- This indicates that QuickSort on a constant array exhibits quadratic complexity $O(n^2)$, which is expected since constant arrays can lead to inefficient partitioning when the pivot selection does not balance the array well.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	$O(n^2)$
MS	**411.69**	285.71	1,777.78	81,632.65	O (n logn)
MC	**414.86**	285.71	1,777.78	81,632.65	O (n logn)
MR	**840.15**	666.67	3,188.39	444,444.44	O (n logn)
QS	**12,660.22**	400	2,988.93	1600	$O(n^2)$
QC	**19,194.24**	133.33	455.42	17777.78	$O(n^2)$

QR) Analysis for QuickSort on a Random Array:

- n min: 250,000
- t min: 30 ms
- n max: 40,000,000
- t max: 26,450 ms

1. Empirical Ratio:

- Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$ = 26450 / 30 ≈ **881.67**

2. Theoretical Ratios:

We compute the theoretical ratios for different complexities:

- Linear Complexity (O(n)):

Linear Ratio = $\frac{\text{n max}}{\text{n min}}$ =40000000 / 250000 =160

- Log-Linear Complexity (O (n \log n)):

Log-Linear Ratio= $\frac{\text{n max} \cdot \log(\text{n max})}{\text{n min} \cdot \log(\text{n min})} = \frac{40000000 \cdot \log(40000000)}{250000 \cdot \log(250000)}$ ≈ 1,328.40

- Quadratic Complexity (O(n^2)):

Quadratic Ratio = $\frac{\text{n max}\hat{}2}{\text{n min}\hat{}2}$ = $40000000^2 / 250000^2$ = 6400

3. Comparison:

- The empirical ratio is approximately 881.67, which is closest to the log-linear ratio of 1,328.40.
- This indicates that QuickSort on a random array behaves more closely to log-linear complexity O (n logn), which is expected since QuickSort is typically efficient on average cases, especially with random inputs.

	Empirical Ratio = $\frac{\text{t max}}{\text{t min}}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	O(n^2)
SC	**18,770**	133.33	455.42	17,777.78	O(n^2)
SR	**19,277**	133.33	455.42	17,777.78	O(n^2)
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	O(n^2)
MS	**411.69**	285.71	1,777.78	81,632.65	O (n logn)
MC	**414.86**	285.71	1,777.78	81,632.65	O (n logn)
MR	**840.15**	666.67	3,188.39	444,444.44	O (n logn)
QS	**12,660.22**	400	2,988.93	1600	O(n^2)
QC	**19,194.24**	133.33	455.42	17777.78	O(n^2)
QR	**881.67**	160	1,328.40	6400	O (n logn)

FINAL CHART

	Empirical Ratio = $\frac{t\ max}{t\ min}$	Linear Ratio	Log-Linear Ratio	Quadratic Ratio	Behaviour
SS	**19,078**	133.33	455.42	17777.783	$O(n^2)$
SC	**18,770**	133.33	455.42	17,777.78	$O(n^2)$
SR	**19,277**	133.33	455.42	17,777.78	$O(n^2)$
IS	**15.73**	15.38	205.72	236.25	O(n)
IC	**13.23**	13.33	176.18	177.78	O(n)
IR	**13,290.59**	111.11	1,168.12	123,456.79	$O(n^2)$
MS	**411.69**	285.71	1,777.78	81,632.65	O (n logn)
MC	**414.86**	285.71	1,777.78	81,632.65	O (n logn)
MR	**840.15**	666.67	3,188.39	444,444.44	O (n logn)
QS	**12,660.22**	400	2,988.93	1600	$O(n^2)$
QC	**19,194.24**	133.33	455.42	17777.78	$O(n^2)$
QR	**881.67**	160	1,328.40	6400	O (n logn)