

Lab Report

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1. Screenshots
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4. Findings

```
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Kints.txt 0
Arrays.sort() a      0.0  20230923_121127 zzh133 1Kints.txt
Arrays.sort() b      0.0  20230923_121127 zzh133 1Kints.txt
Arrays.sort() c      0.0  20230923_121127 zzh133 1Kints.txt
Arrays.sort() d      0.0  20230923_121127 zzh133 1Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Kints.txt 1
BubbleSort a        4.0  20230923_121132 zzh133 1Kints.txt
BubbleSort b        1.0  20230923_121132 zzh133 1Kints.txt
BubbleSort c        3.0  20230923_121132 zzh133 1Kints.txt
BubbleSort d        0.0  20230923_121132 zzh133 1Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Kints.txt 2
SelectionSort a     2.0  20230923_121133 zzh133 1Kints.txt
SelectionSort b     0.0  20230923_121133 zzh133 1Kints.txt
SelectionSort c     2.0  20230923_121133 zzh133 1Kints.txt
SelectionSort d     1.0  20230923_121133 zzh133 1Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Kints.txt 3
InsertionSort a    3.0  20230923_121135 zzh133 1Kints.txt
InsertionSort b    0.0  20230923_121135 zzh133 1Kints.txt
InsertionSort c    0.0  20230923_121135 zzh133 1Kints.txt
InsertionSort d    1.0  20230923_121135 zzh133 1Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Kints.txt 4
Mergesort a        1.0  20230923_121136 zzh133 1Kints.txt
Mergesort b        1.0  20230923_121136 zzh133 1Kints.txt
Mergesort c        0.0  20230923_121136 zzh133 1Kints.txt
Mergesort d        0.0  20230923_121136 zzh133 1Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Kints.txt 5
Quicksort a       0.0  20230923_121137 zzh133 1Kints.txt
Quicksort b       2.0  20230923_121137 zzh133 1Kints.txt
Quicksort c       2.0  20230923_121137 zzh133 1Kints.txt
Quicksort d       0.0  20230923_121137 zzh133 1Kints.txt
```

```
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 2Kints.txt 0
Arrays.sort() a      1.0  20230923_093753 zzh133 2Kints.txt
Arrays.sort() b      0.0  20230923_093753 zzh133 2Kints.txt
Arrays.sort() c      0.0  20230923_093753 zzh133 2Kints.txt
Arrays.sort() d      0.0  20230923_093753 zzh133 2Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 2Kints.txt 1
BubbleSort a        8.0  20230923_093821 zzh133 2Kints.txt
BubbleSort b       10.0  20230923_093821 zzh133 2Kints.txt
BubbleSort c       14.0  20230923_093821 zzh133 2Kints.txt
BubbleSort d       11.0  20230923_093821 zzh133 2Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 2Kints.txt 2
SelectionSort a    6.0  20230923_093823 zzh133 2Kints.txt
SelectionSort b    2.0  20230923_093823 zzh133 2Kints.txt
SelectionSort c    1.0  20230923_093823 zzh133 2Kints.txt
SelectionSort d    2.0  20230923_093823 zzh133 2Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 2Kints.txt 3
InsertionSort a   7.0  20230923_093825 zzh133 2Kints.txt
InsertionSort b   0.0  20230923_093825 zzh133 2Kints.txt
InsertionSort c  10.0  20230923_093825 zzh133 2Kints.txt
InsertionSort d   1.0  20230923_093825 zzh133 2Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 2Kints.txt 4
Mergesort a        1.0  20230923_093826 zzh133 2Kints.txt
Mergesort b        0.0  20230923_093826 zzh133 2Kints.txt
Mergesort c        0.0  20230923_093826 zzh133 2Kints.txt
Mergesort d        1.0  20230923_093826 zzh133 2Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 2Kints.txt 5
Quicksort a       1.0  20230923_093828 zzh133 2Kints.txt
Quicksort b       9.0  20230923_093828 zzh133 2Kints.txt
Quicksort c       9.0  20230923_093828 zzh133 2Kints.txt
Quicksort d       1.0  20230923_093828 zzh133 2Kints.txt
```

```
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 4Kints.txt 0
Arrays.sort() a      0.0  20230923_093940  zzh133  4Kints.txt
Arrays.sort() b      0.0  20230923_093940  zzh133  4Kints.txt
Arrays.sort() c      0.0  20230923_093940  zzh133  4Kints.txt
Arrays.sort() d      1.0  20230923_093940  zzh133  4Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 4Kints.txt 1
BubbleSort a        20.0 20230923_093944  zzh133  4Kints.txt
BubbleSort b        41.0 20230923_093945  zzh133  4Kints.txt
BubbleSort c        9.0  20230923_093945  zzh133  4Kints.txt
BubbleSort d        3.0  20230923_093945  zzh133  4Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 4Kints.txt 2
SelectionSort a     15.0 20230923_093946  zzh133  4Kints.txt
SelectionSort b     23.0 20230923_093946  zzh133  4Kints.txt
SelectionSort c     23.0 20230923_093946  zzh133  4Kints.txt
SelectionSort d     14.0 20230923_093946  zzh133  4Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 4Kints.txt 3
InsertionSort a     14.0 20230923_093947  zzh133  4Kints.txt
InsertionSort b     0.0  20230923_093947  zzh133  4Kints.txt
InsertionSort c     37.0 20230923_093947  zzh133  4Kints.txt
InsertionSort d     4.0  20230923_093947  zzh133  4Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 4Kints.txt 4
Mergesort a         2.0  20230923_093948  zzh133  4Kints.txt
Mergesort b         0.0  20230923_093948  zzh133  4Kints.txt
Mergesort c         0.0  20230923_093948  zzh133  4Kints.txt
Mergesort d         0.0  20230923_093948  zzh133  4Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 4Kints.txt 5
Quicksort a        1.0  20230923_093950  zzh133  4Kints.txt
Quicksort b        6.0  20230923_093950  zzh133  4Kints.txt
Quicksort c        5.0  20230923_093950  zzh133  4Kints.txt
Quicksort d        0.0  20230923_093950  zzh133  4Kints.txt
```

```
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 8Kints.txt 0
Arrays.sort() a      2.0  20230923_094133  zzh133  8Kints.txt
Arrays.sort() b      0.0  20230923_094133  zzh133  8Kints.txt
Arrays.sort() c      0.0  20230923_094133  zzh133  8Kints.txt
Arrays.sort() d      1.0  20230923_094133  zzh133  8Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 8Kints.txt 1
BubbleSort a        66.0 20230923_094135  zzh133  8Kints.txt
BubbleSort b        36.0 20230923_094135  zzh133  8Kints.txt
BubbleSort c        37.0 20230923_094135  zzh133  8Kints.txt
BubbleSort d        37.0 20230923_094135  zzh133  8Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 8Kints.txt 2
SelectionSort a     32.0 20230923_094137  zzh133  8Kints.txt
SelectionSort b     32.0 20230923_094137  zzh133  8Kints.txt
SelectionSort c     31.0 20230923_094137  zzh133  8Kints.txt
SelectionSort d     30.0 20230923_094137  zzh133  8Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 8Kints.txt 3
InsertionSort a     17.0 20230923_094139  zzh133  8Kints.txt
InsertionSort b     0.0  20230923_094139  zzh133  8Kints.txt
InsertionSort c     26.0 20230923_094139  zzh133  8Kints.txt
InsertionSort d     3.0  20230923_094139  zzh133  8Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 8Kints.txt 4
Mergesort a         1.0  20230923_094145  zzh133  8Kints.txt
Mergesort b         1.0  20230923_094145  zzh133  8Kints.txt
Mergesort c         0.0  20230923_094145  zzh133  8Kints.txt
Mergesort d         1.0  20230923_094145  zzh133  8Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 8Kints.txt 5
Quicksort a        2.0  20230923_094148  zzh133  8Kints.txt
Quicksort b        32.0 20230923_094148  zzh133  8Kints.txt
Quicksort c        24.0 20230923_094148  zzh133  8Kints.txt
Quicksort d        1.0  20230923_094148  zzh133  8Kints.txt
```

```
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 16Kints.txt 0
Arrays.sort() a      2.0  20230923_094221  zzh133  16Kints.txt
Arrays.sort() b      0.0  20230923_094221  zzh133  16Kints.txt
Arrays.sort() c      1.0  20230923_094221  zzh133  16Kints.txt
Arrays.sort() d      1.0  20230923_094221  zzh133  16Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 16Kints.txt 1
BubbleSort a       296.0 20230923_094231  zzh133  16Kints.txt
BubbleSort b       126.0 20230923_094231  zzh133  16Kints.txt
BubbleSort c       128.0 20230923_094231  zzh133  16Kints.txt
BubbleSort d       94.0  20230923_094231  zzh133  16Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 16Kints.txt 2
SelectionSort a    96.0  20230923_094234  zzh133  16Kints.txt
SelectionSort b    97.0  20230923_094234  zzh133  16Kints.txt
SelectionSort c    67.0  20230923_094234  zzh133  16Kints.txt
SelectionSort d    93.0  20230923_094234  zzh133  16Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 16Kints.txt 3
InsertionSort a   37.0  20230923_094236  zzh133  16Kints.txt
InsertionSort b   0.0   20230923_094236  zzh133  16Kints.txt
InsertionSort c   68.0  20230923_094236  zzh133  16Kints.txt
InsertionSort d   8.0   20230923_094236  zzh133  16Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 16Kints.txt 4
Mergesort a       3.0   20230923_094238  zzh133  16Kints.txt
Mergesort b       1.0   20230923_094238  zzh133  16Kints.txt
Mergesort c       1.0   20230923_094238  zzh133  16Kints.txt
Mergesort d       2.0   20230923_094238  zzh133  16Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 16Kints.txt 5
Quicksort a      4.0   20230923_094240  zzh133  16Kints.txt
Quicksort b     181.0  20230923_094240  zzh133  16Kints.txt
Quicksort c     90.0  20230923_094240  zzh133  16Kints.txt
Quicksort d     1.0   20230923_094240  zzh133  16Kints.txt
```

```
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 32Kints.txt 0
Arrays.sort() a      5.0  20230923_095740  zzh133  32Kints.txt
Arrays.sort() b      1.0  20230923_095741  zzh133  32Kints.txt
Arrays.sort() c      1.0  20230923_095741  zzh133  32Kints.txt
Arrays.sort() d      5.0  20230923_095741  zzh133  32Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 32Kints.txt 1
BubbleSort a      1374.0 20230923_095748  zzh133  32Kints.txt
BubbleSort b      518.0  20230923_095749  zzh133  32Kints.txt
BubbleSort c      516.0  20230923_095749  zzh133  32Kints.txt
BubbleSort d      387.0  20230923_095749  zzh133  32Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 32Kints.txt 2
SelectionSort a   403.0  20230923_095752  zzh133  32Kints.txt
SelectionSort b   384.0  20230923_095752  zzh133  32Kints.txt
SelectionSort c   279.0  20230923_095752  zzh133  32Kints.txt
SelectionSort d   375.0  20230923_095753  zzh133  32Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 32Kints.txt 3
InsertionSort a   140.0  20230923_095755  zzh133  32Kints.txt
InsertionSort b   1.0   20230923_095755  zzh133  32Kints.txt
InsertionSort c   270.0  20230923_095755  zzh133  32Kints.txt
InsertionSort d   34.0  20230923_095755  zzh133  32Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 32Kints.txt 4
Mergesort a       7.0   20230923_095757  zzh133  32Kints.txt
Mergesort b       3.0   20230923_095757  zzh133  32Kints.txt
Mergesort c       3.0   20230923_095757  zzh133  32Kints.txt
Mergesort d       5.0   20230923_095757  zzh133  32Kints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java -Xss4m Sorting 32Kints.txt 5
Quicksort a      4.0   20230923_095817  zzh133  32Kints.txt
Quicksort b     514.0  20230923_095818  zzh133  32Kints.txt
Quicksort c     328.0  20230923_095818  zzh133  32Kints.txt
Quicksort d     2.0   20230923_095818  zzh133  32Kints.txt
```

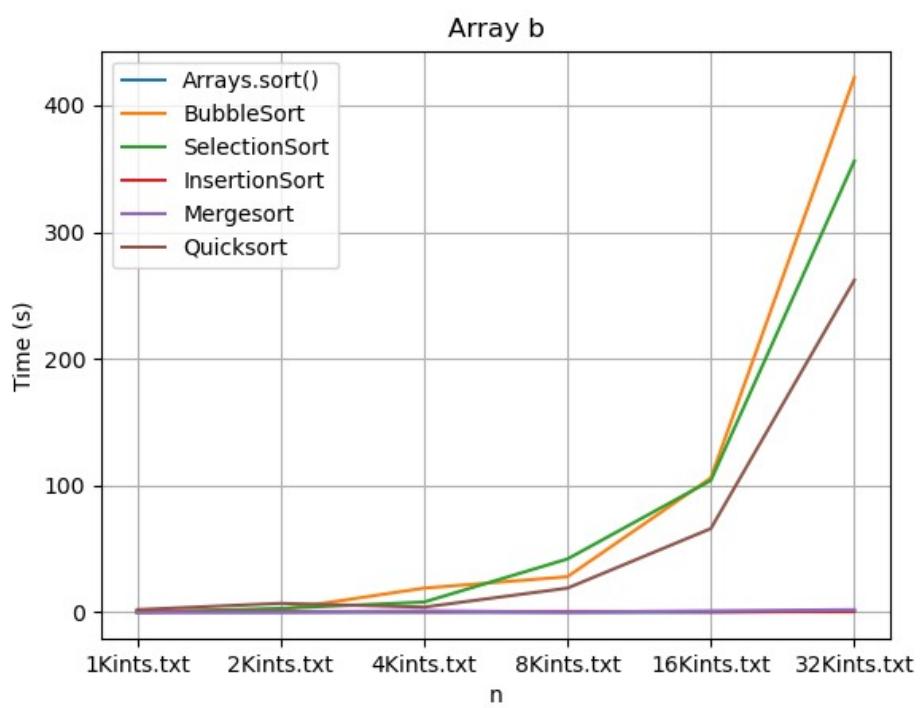
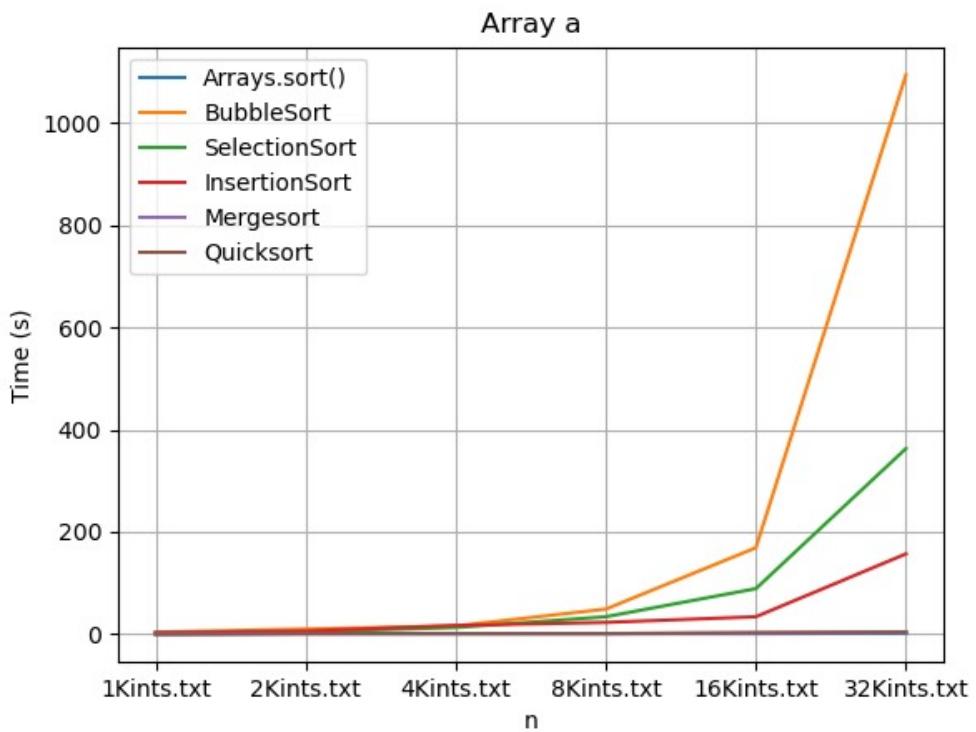
```
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Mints.txt 0
Arrays.sort() a      85.0   20230923_173227 zzh133 1Mints.txt
Arrays.sort() b      4.0    20230923_173227 zzh133 1Mints.txt
Arrays.sort() c      4.0    20230923_173227 zzh133 1Mints.txt
Arrays.sort() d     45.0   20230923_173227 zzh133 1Mints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Mints.txt 1
BubbleSort a 1407563.0 20230923_175600 zzh133 1Mints.txt
BubbleSort b 135721.0 20230923_175816 zzh133 1Mints.txt
BubbleSort c 506763.0 20230923_180642 zzh133 1Mints.txt
BubbleSort d 384756.0 20230923_181307 zzh133 1Mints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Mints.txt 2
SelectionSort a 369822.0 20230923_182546 zzh133 1Mints.txt
SelectionSort b 170964.0 20230923_182838 zzh133 1Mints.txt
SelectionSort c 256940.0 20230923_183255 zzh133 1Mints.txt
SelectionSort d 169643.0 20230923_183544 zzh133 1Mints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Mints.txt 3
InsertionSort a 127779.0 20230923_183807 zzh133 1Mints.txt
InsertionSort b 2.0    20230923_183808 zzh133 1Mints.txt
InsertionSort c 255897.0 20230923_184224 zzh133 1Mints.txt
InsertionSort d 29328.0 20230923_184253 zzh133 1Mints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java Sorting 1Mints.txt 4
Mergesort a 193.0   20230923_185052 zzh133 1Mints.txt
Mergesort b 97.0    20230923_185053 zzh133 1Mints.txt
Mergesort c 51.0    20230923_185053 zzh133 1Mints.txt
Mergesort d 74.0    20230923_185053 zzh133 1Mints.txt
[dhcp-10-5-253-123:Lab 3 zzh$ java -Xss1024m Sorting 1Mints.txt 5
Quicksort a 104.0   20230923_185647 zzh133 1Mints.txt
Quicksort b 672187.0 20230923_190759 zzh133 1Mints.txt
Quicksort c 390749.0 20230923_191430 zzh133 1Mints.txt
Quicksort d 104.0   20230923_191431 zzh133 1Mints.txt
```

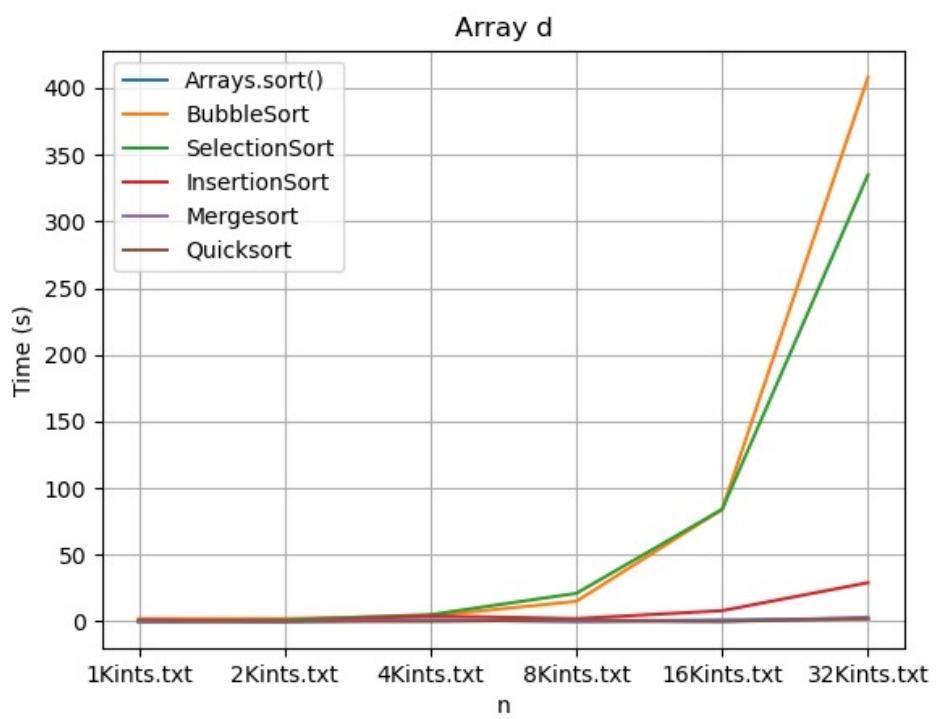
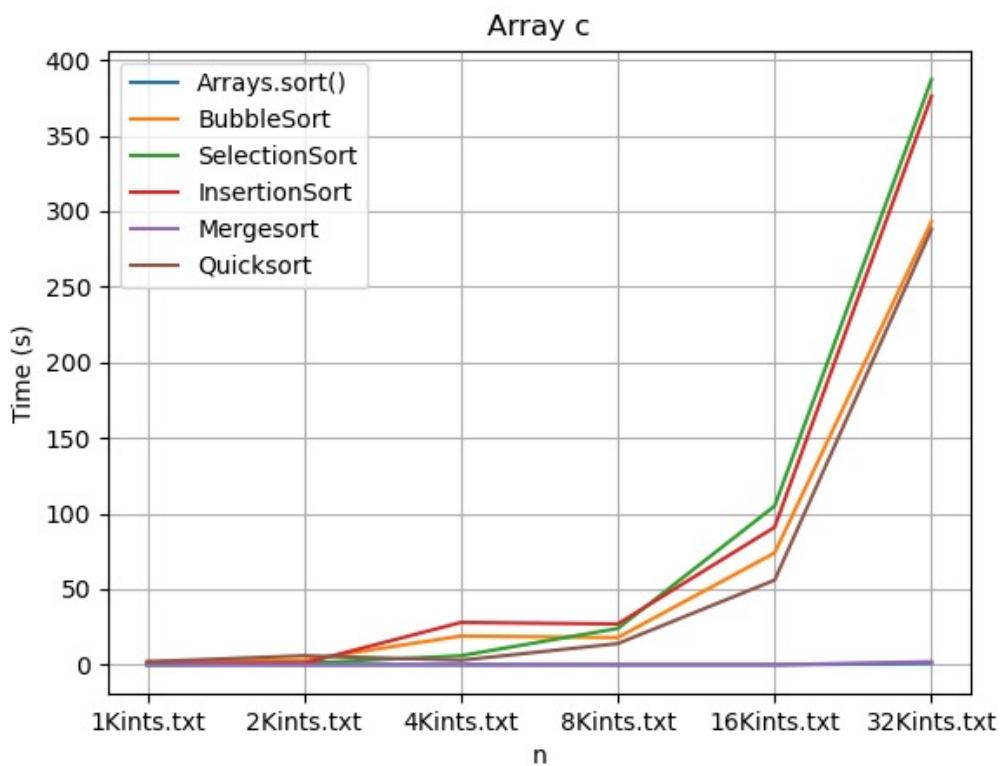
	A	B	C	D	E	F	G	H
1	a	1Kints	2Kints	4Kints	8Kints	16Kints	32Kints	1Mints
2	Arrays.sort()	0.0	1.0	0.0	2.0	2.0	5.0	85.0
3	Bubble Sort	0.0	8.0	20.0	66.0	296.0	1374.0	1407563.0
4	Selection Sort	0.0	6.0	15.0	32.0	96.0	403.0	369822.0
5	Insertion Sort	0.0	7.0	14.0	17.0	37.0	140.0	127779.0
6	Mergesort	0.0	1.0	2.0	1.0	3.0	7.0	193.0
7	Quicksort	0.0	1.0	1.0	2.0	4.0	4.0	104.0

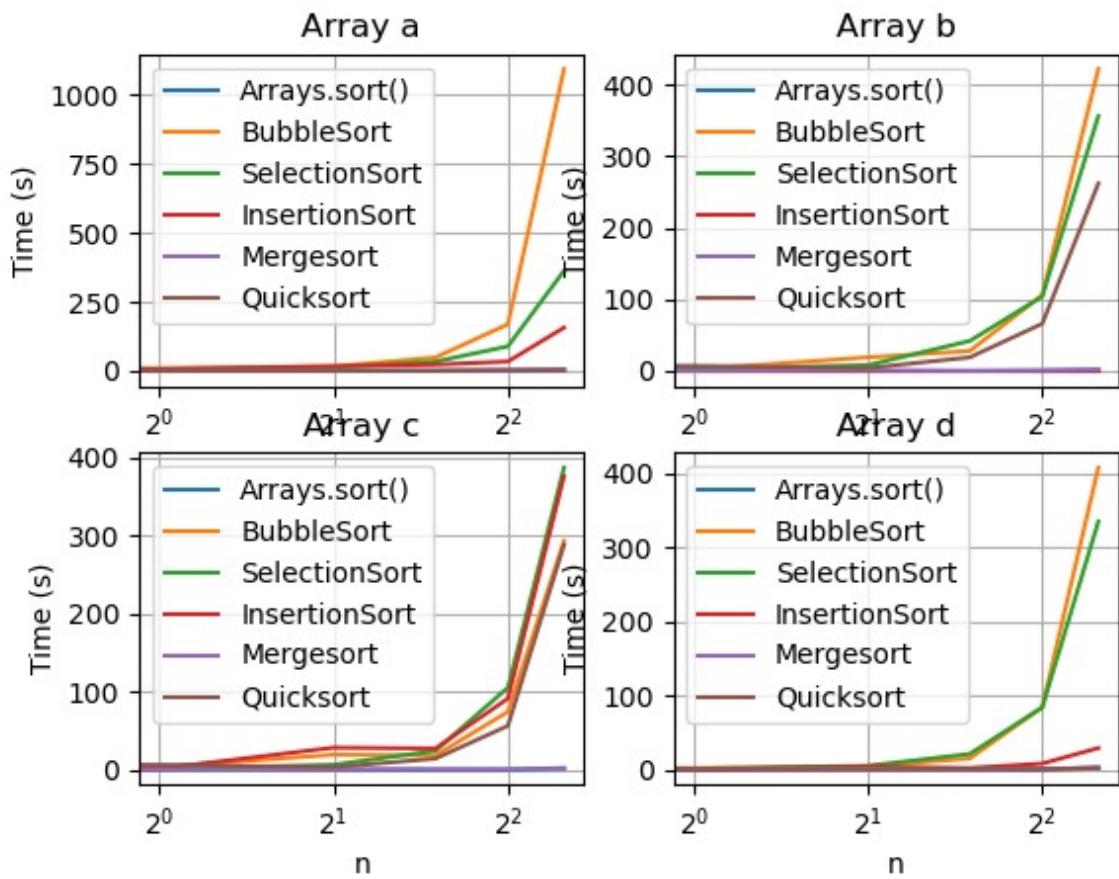
	A	B	C	D	E	F	G	H
	b	1Kints	2Kints	4Kints	8Kints	16Kints	32Kints	1Mints
	Arrays.sort()	0.0	0.0	0.0	0.0	0.0	1.0	4.0
	Bubble Sort	0.0	10.0	41.0	36.0	126.0	518.0	135721.0
	Selection Sort	0.0	2.0	23.0	32.0	97.0	384.0	170964.0
	Insertion Sort	0.0	0.0	0.0	0.0	0.0	1.0	2.0
	Mergesort	0.0	0.0	0.0	1.0	1.0	3.0	97.0
	Quicksort	0.0	9.0	6.0	32.0	181.0	514.0	672187.0

	c	1Kints	2Kints	4Kints	8Kints	16Kints	32Kints	1Mints
	Arrays.sort()	0.0	0.0	0.0	0.0	1.0	1.0	4.0
	Bubble Sort	0.0	14.0	9.0	37.0	128.0	516.0	506763.9
	Selection Sort	0.0	1.0	23.0	31.0	67.0	279.0	256940.0
	Insertion Sort	0.0	10.0	37.0	26.0	68.0	270.0	255897.0
	Mergesort	0.0	0.0	0.0	0.0	1.0	3.0	51.0
	Quicksort	0.0	9.0	5.0	24.0	90.0	328.0	390749.0

	d	1Kints	2Kints	4Kints	8Kints	16Kints	32Kints	1Mints
	Arrays.sort()	0.0	0.0	1.0	1.0	1.0	5.0	45.0
	Bubble Sort	0.0	11.0	3.0	37.0	94.0	387.0	384756.0
	Selection Sort	0.0	2.0	14.0	30.0	93.0	375.0	169643.0
	Insertion Sort	0.0	1.0	4.0	3.0	8.0	34.0	29328.0
	Mergesort	0.0	1.0	0.0	1.0	2.0	5.0	74.0
	Quicksort	0.0	1.0	0.0	1.0	1.0	2.0	104.0







Findings:

Figure a as an example, the three sorting methods with time complexity $O(n \log n)$ are obviously much faster than $O(n^2)$ sorting

- For well-ordered arrays, the complexity of insertion sort can reach $O(n)$, but the specific complexity of fast sort is related to the pivot selection, the complexity of selection, Insertion sort is $O(n^2)$
- For the Bubble Sort the complexity of time is $O(n^2)$, Mergesort time complexity is $O(n \log(n))$, QuickSort time complexity is from $O(n \log(n))$ to $O(n^2)$
- In Figure c, the worst case of reverse order, the time complexity of fast sort is $O(n^2)$, while the time complexity of subsumption sort is $O(n \log n)$
- When dealing with almost sorted arrays, insertion sort is very efficient and few elements need to be moved during the comparison process