Sorting algorithms

- a brief comparison -

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Summary

- Within this power point I want to illustrate the best usecase for the following sorting algorithms choosen
- The tests were based on positive integers
- They were performed using different parameters, such as number of elements and max-value

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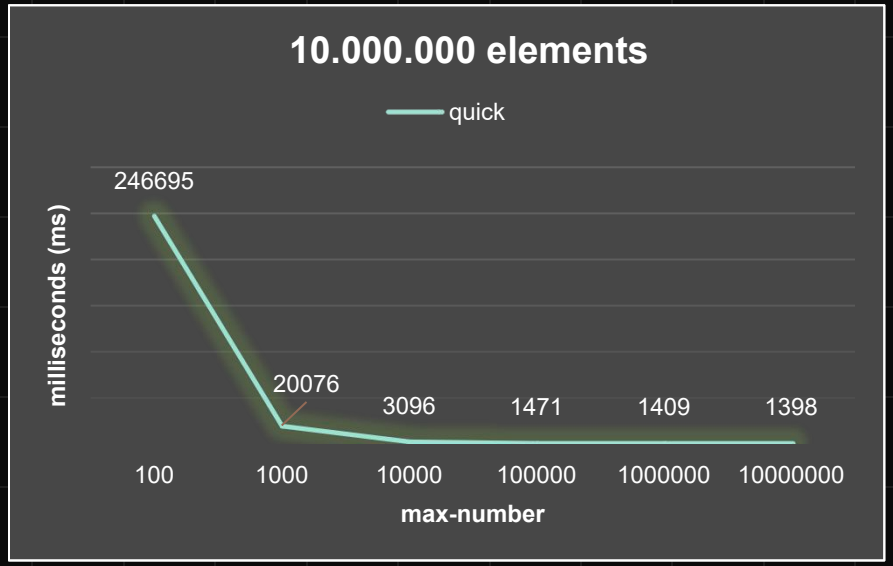
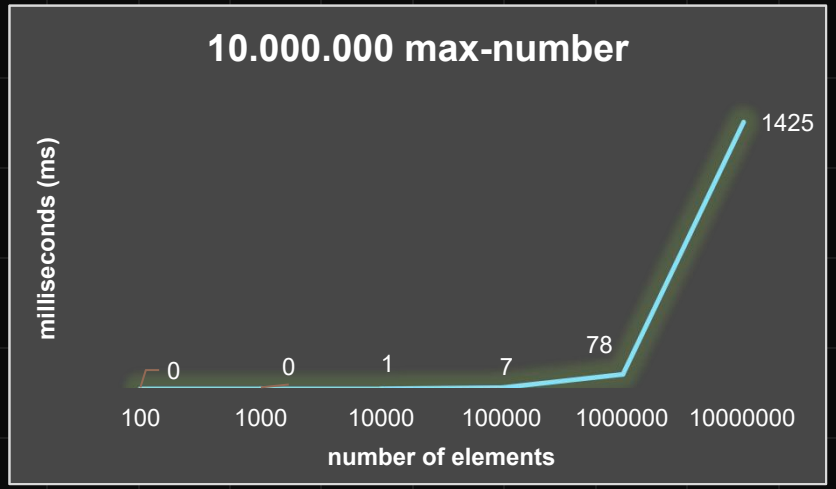
Quick sort

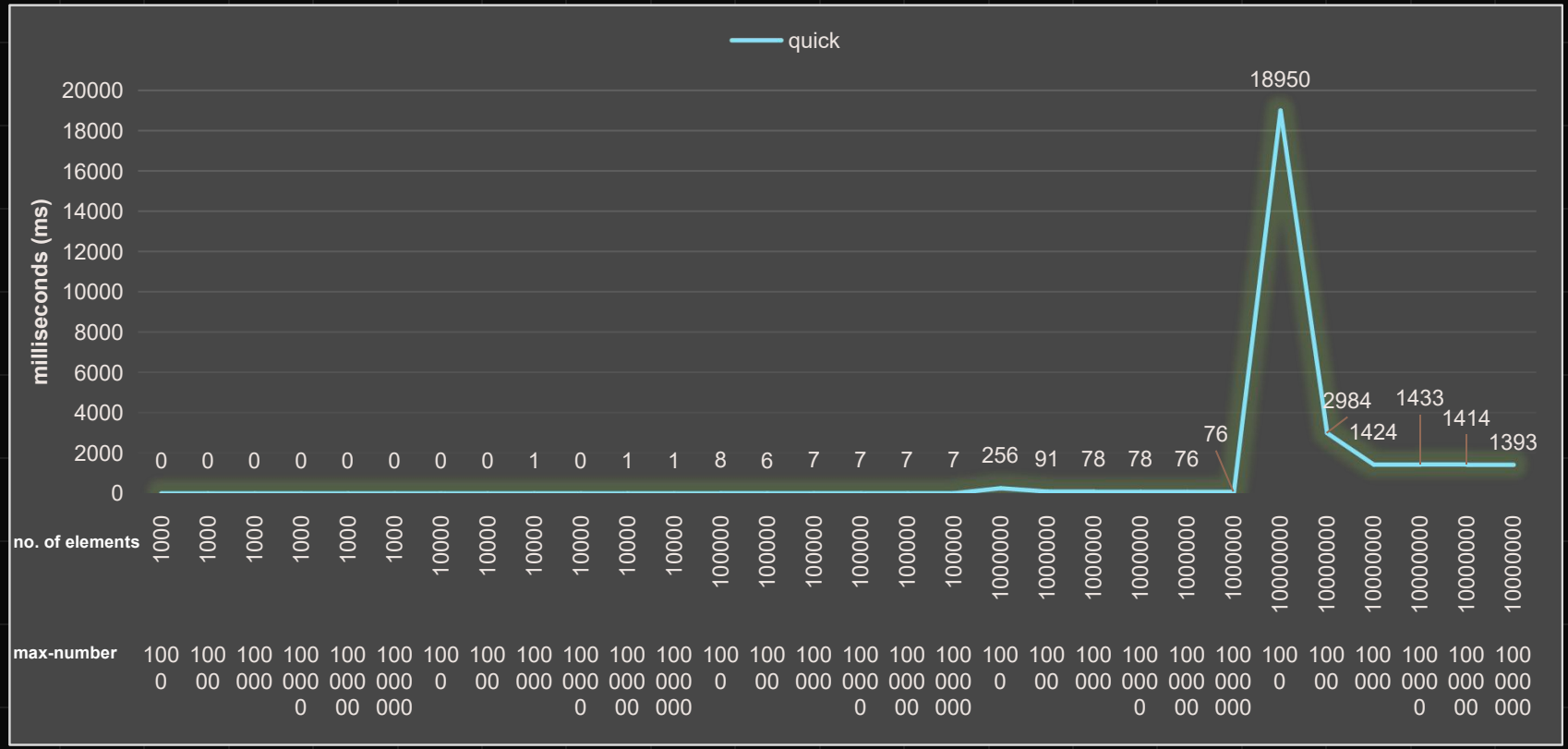
- Having a debateble Big-O complexity from O(n logn) to O(n^2), quick sort is a divide and conquer algorithm, based on partitiong
- In my implementation, the pivot is chosen randomly

Worst case	Average case	Best case	Memory	Stable
n logn	n logn	n^2	n	no

Quick sort


10.000.000 elements
quick
milliseconds (ms)
246695
20076
3096
1471
1409
1398
100
1000
10000
100000
1000000
10000000
max-number


10.000.000 max-number
milliseconds (ms)
0
0
1
7
78
1425
100
1000
10000
100000
1000000
10000000
number of elements

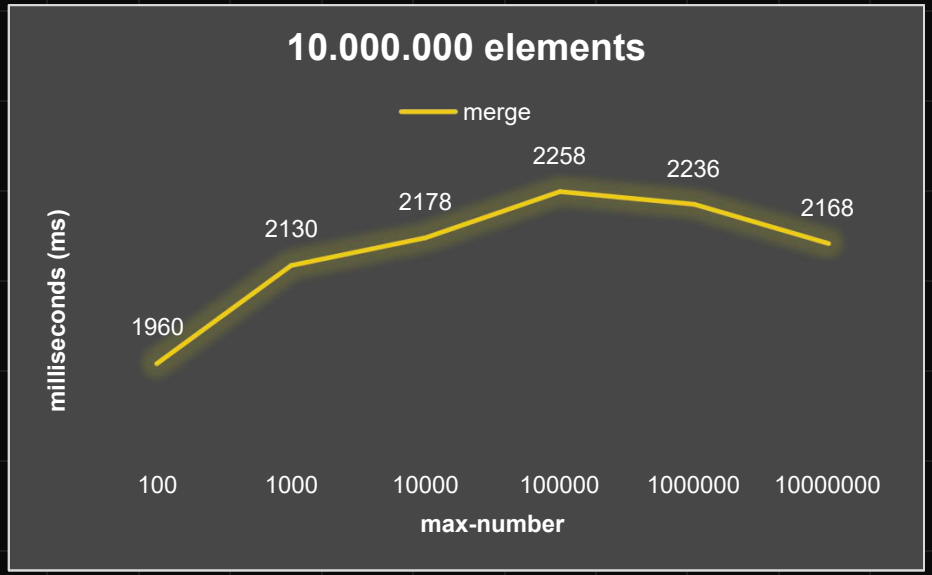

quick
milliseconds (ms)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0 0 0 0 0 0 0 0 1 0 1 1 8 6 7 7 7 7 256 91 78 78 76 76 18950 2984 1424 1433 1414 1393
no. of elements
1000 1000 1000 1000 1000 1000 10000 10000 10000 10000 10000 10000 100000 100000 100000 100000 100000 100000 1000000 1000000 1000000 1000000 1000000 1000000 10000000 10000000 10000000 10000000 10000000 10000000
max-number
1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000

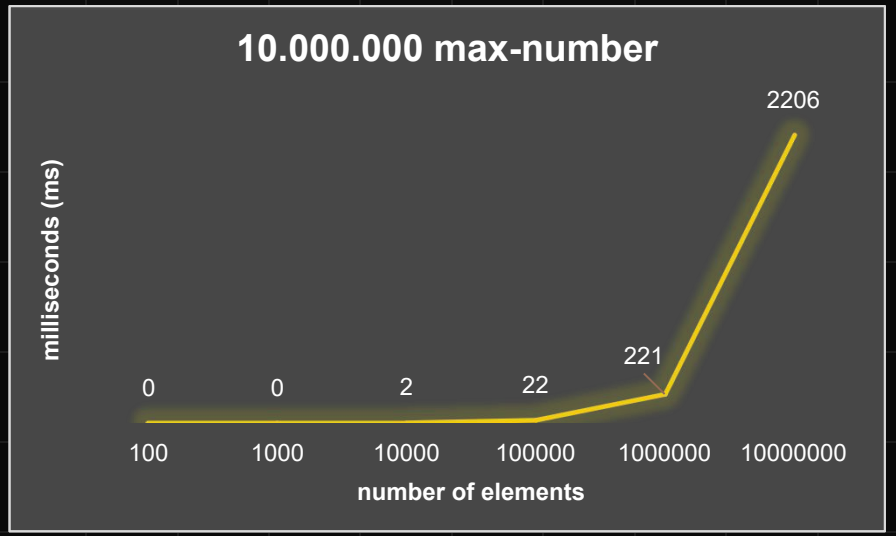
Merge sort

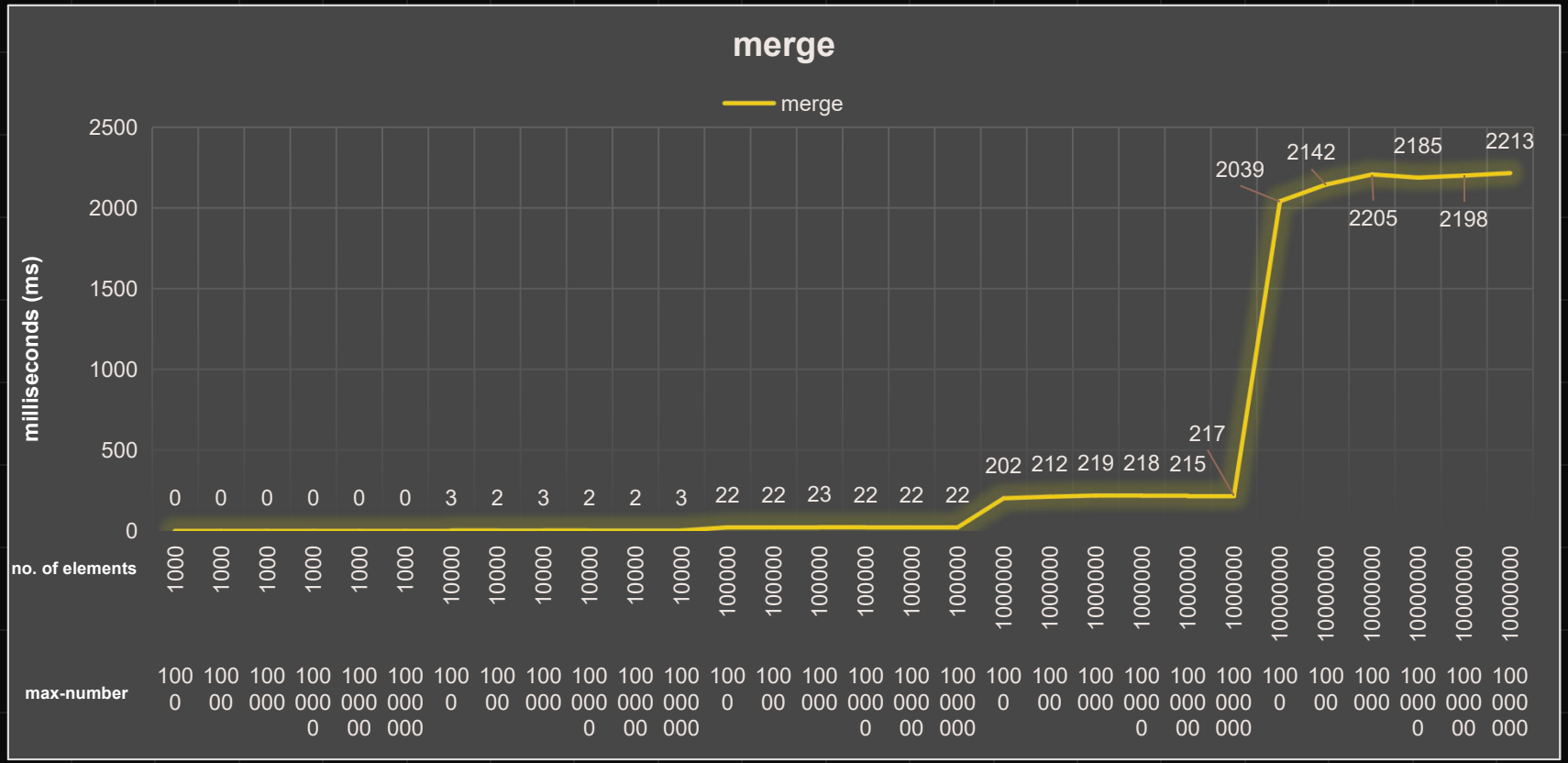
- A merging algorithm, with Big-O(n logn), easy to implement and fast

Worst case	Average case	Best case	Memory	Stable
n logn	n logn	n logn	n	yes

Merge sort


10.000.000 elements
merge
milliseconds (ms)
1960
2130
2178
2258
2236
2168
100
1000
10000
100000
1000000
10000000
max-number


10.000.000 max-number
milliseconds (ms)
0
0
2
22
221
2206
100
1000
10000
100000
1000000
10000000
number of elements


merge
merge
milliseconds (ms)
2500
2000
1500
1000
500
0
0 0 0 0 0 0 3 2 3 2 2 3 22 22 23 22 22 22 202 212 219 218 215 217 2039 2142 2205 2198 2185 2213
no. of elements
1000 1000 1000 1000 1000 1000 10000 10000 10000 10000 10000 10000 100000 100000 100000 100000 100000 100000 1000000 1000000 1000000 1000000 1000000 1000000 10000000 10000000 10000000 10000000 10000000 10000000
max-number
1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000

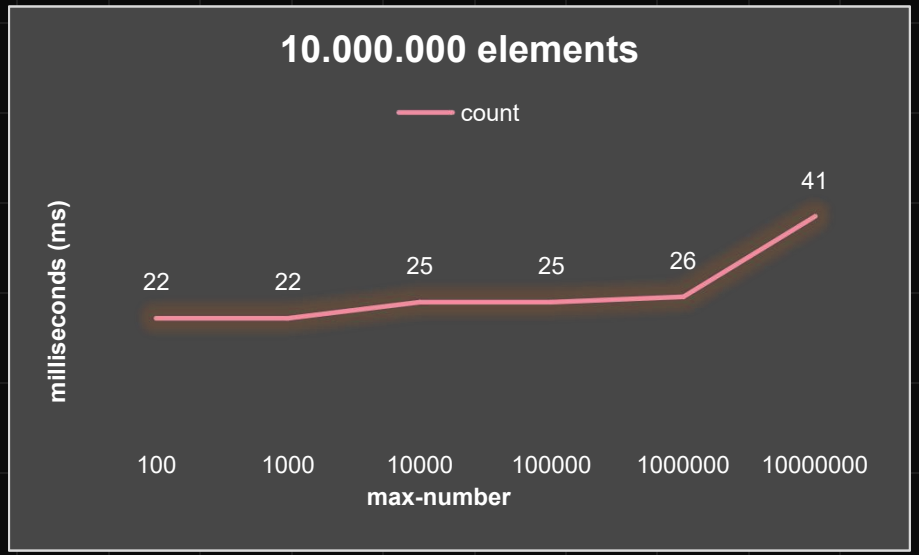
Count sort

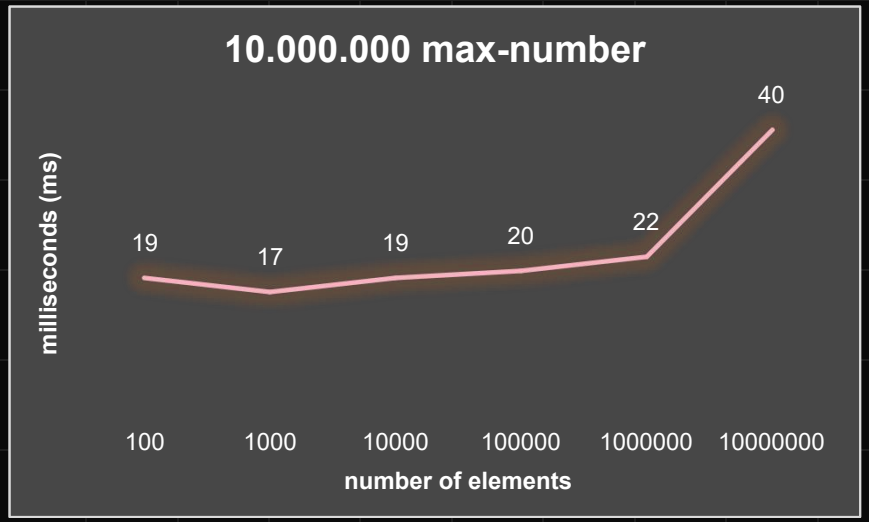
- Based on counting, an very efficient algorithm for unsigned integer numbers. It can be modify to work with negative and floats too.

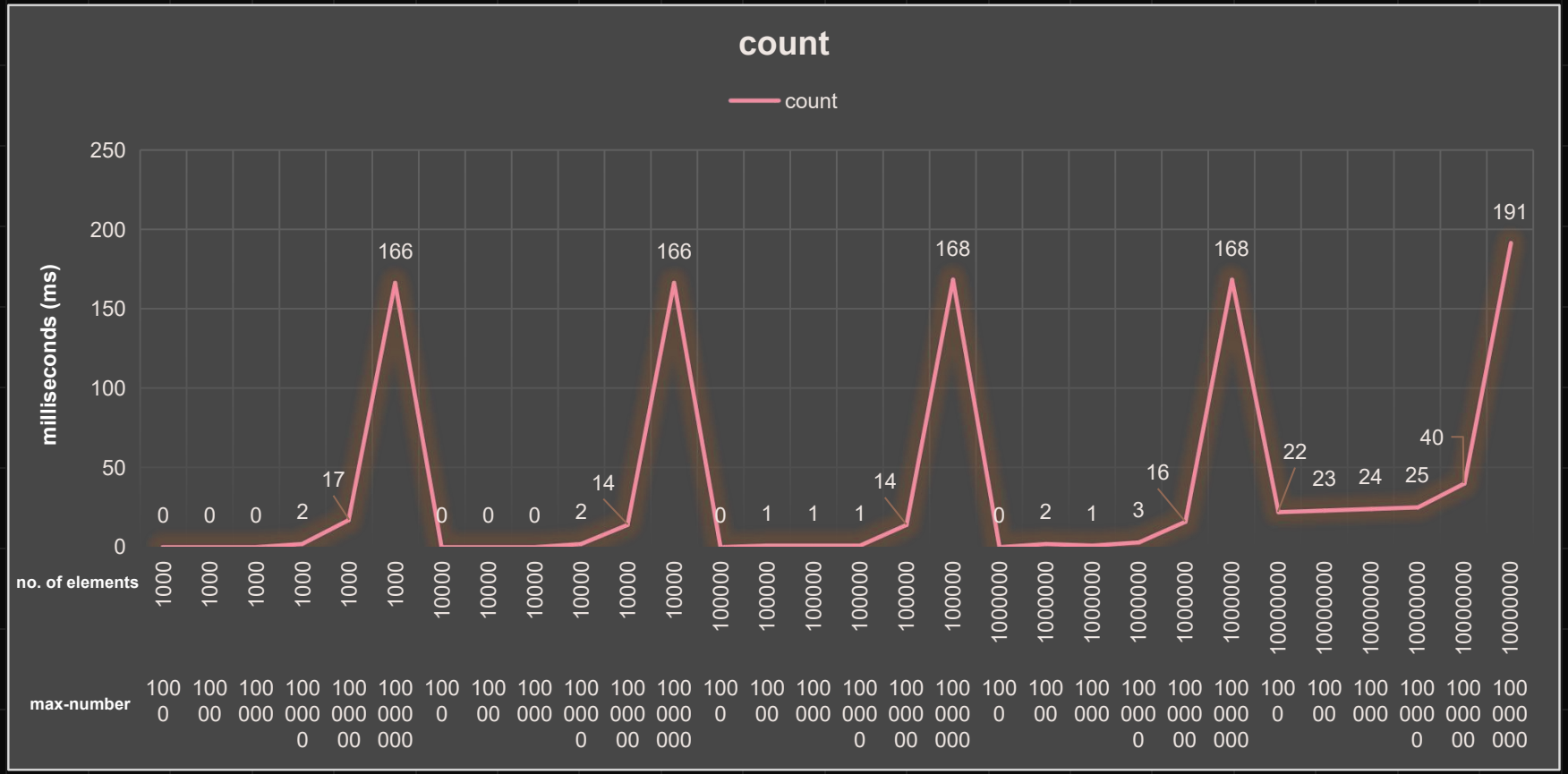
Worst case	Average case	Best case	Memory	Stable
-	n + r	n + r	n + r	yes

- n - represents the number of elements
- r - represents the max-number (range)

Count sort


10.000.000 elements
count
milliseconds (ms)
22
22
25
25
26
41
100
1000
10000
100000
1000000
10000000
max-number


10.000.000 max-number
milliseconds (ms)
19
17
19
20
22
40
100
1000
10000
100000
1000000
10000000
number of elements

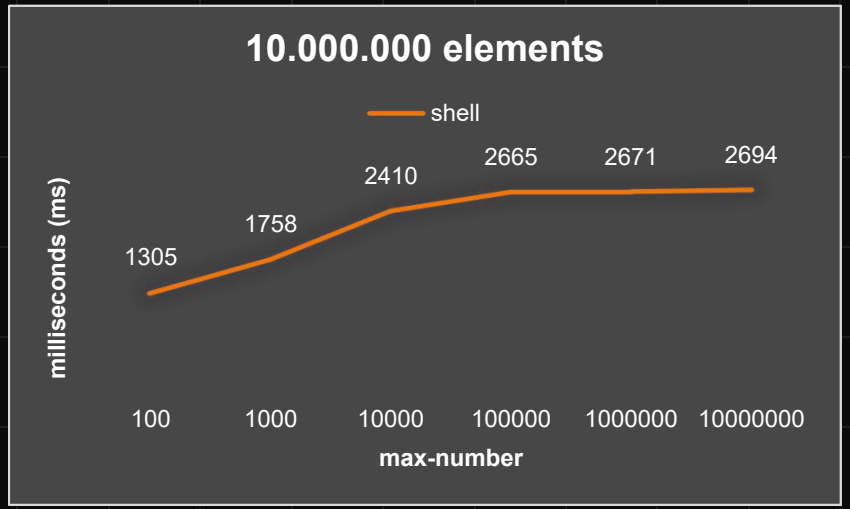

count
count
milliseconds (ms)
250
200
150
100
50
0
no. of elements
max-number
0 0 0 2 17 166 0 0 0 2 14 166 0 1 1 1 14 168 0 2 1 3 16 168 22 23 24 25 40 191
1000 1000 1000 1000 1000 1000 10000 10000 10000 10000 10000 10000 100000 100000 100000 100000 100000 100000 1000000 1000000 1000000 1000000 1000000 1000000 10000000 10000000 10000000 10000000 10000000 10000000
1000 100 1000 10000 100000 1000000 1000 100 1000 10000 100000 1000000 1000 100 1000 10000 100000 1000000 1000 100 1000 10000 100000 1000000 1000 100 1000 10000 100000 1000000

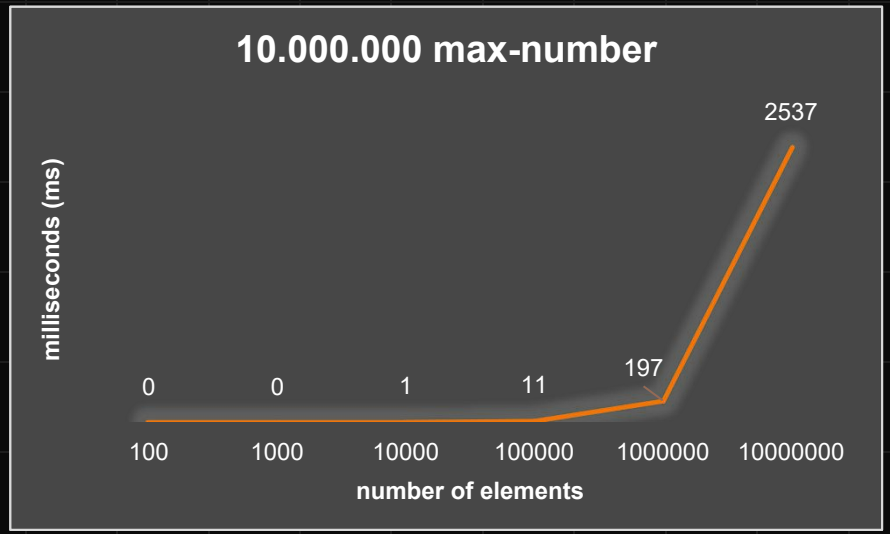
Shell sort

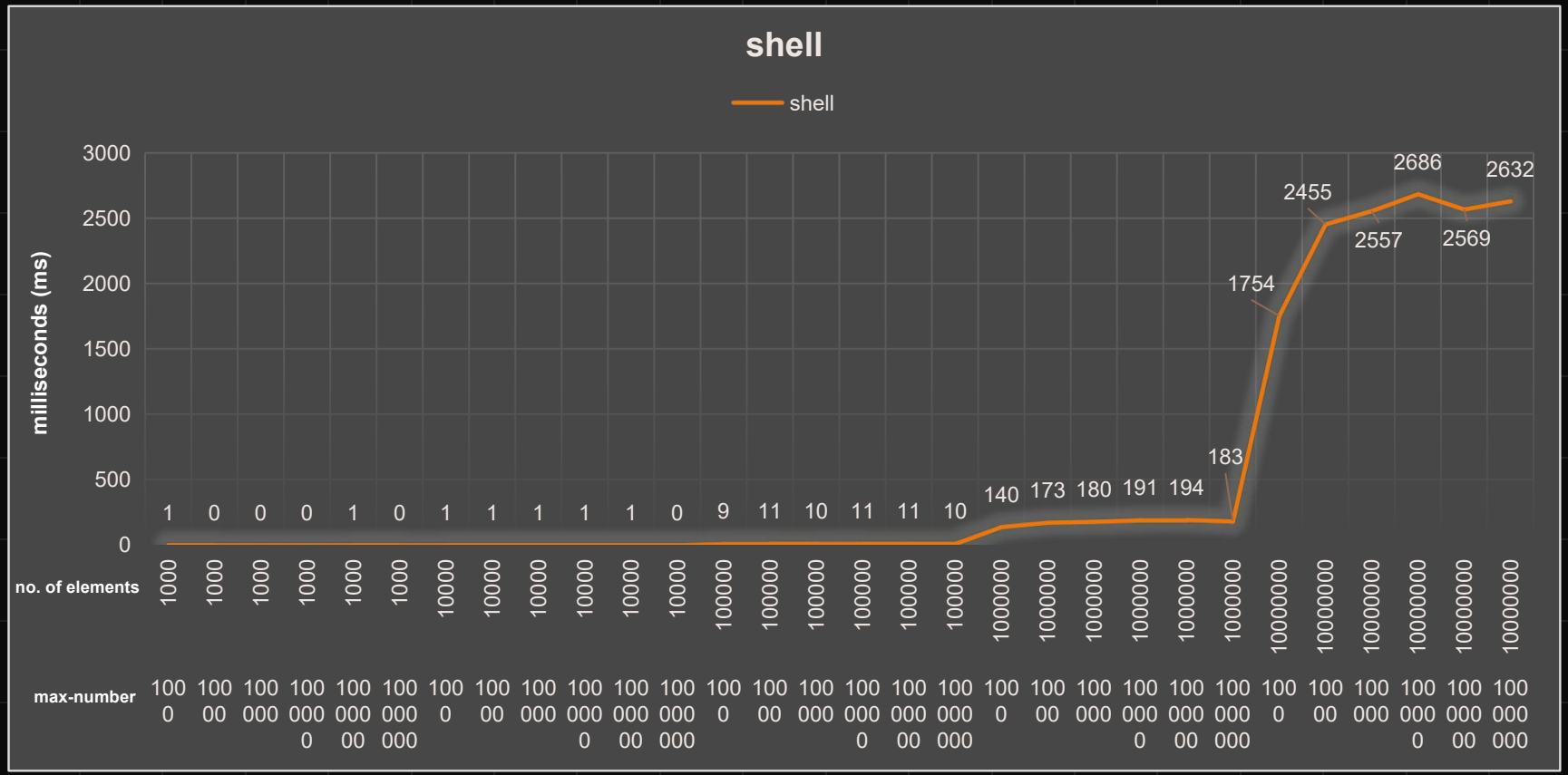
- An insertion algorithm, an improvement to bubble sort, that eliminates more than one inversion at a time.
- My implementation utilise the standard shell sort gap, dividing by 2

Worst case	Average case	Best case	Memory	Stable
n logn	$n^{4/3}$	$n^{3/2}$	1	no

Shell sort


10.000.000 elements
shell
milliseconds (ms)
1305
1758
2410
2665
2671
2694
100
1000
10000
100000
1000000
10000000
max-number


10.000.000 max-number
milliseconds (ms)
0
0
1
11
197
2537
100
1000
10000
100000
1000000
10000000
number of elements

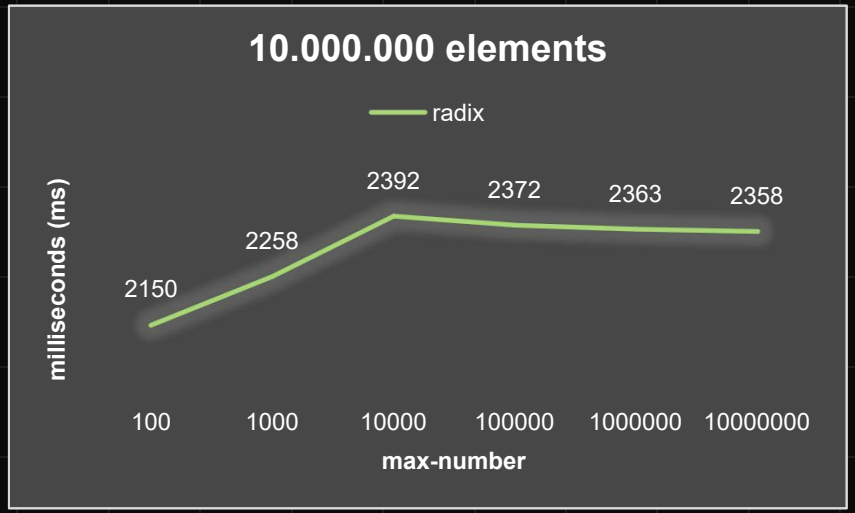

shell
shell
milliseconds (ms)
3000
2500
2000
1500
1000
500
0
1 0 0 0 1 0 1 1 1 1 1 0 9 11 10 11 11 10 140 173 180 191 194 183 1754 2455 2557 2569 2686 2632
no. of elements
1000 1000 1000 1000 1000 1000 10000 10000 10000 10000 10000 10000 100000 100000 100000 100000 100000 100000 1000000 1000000 1000000 1000000 1000000 1000000 10000000 10000000 10000000 10000000 10000000 10000000
max-number
1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000

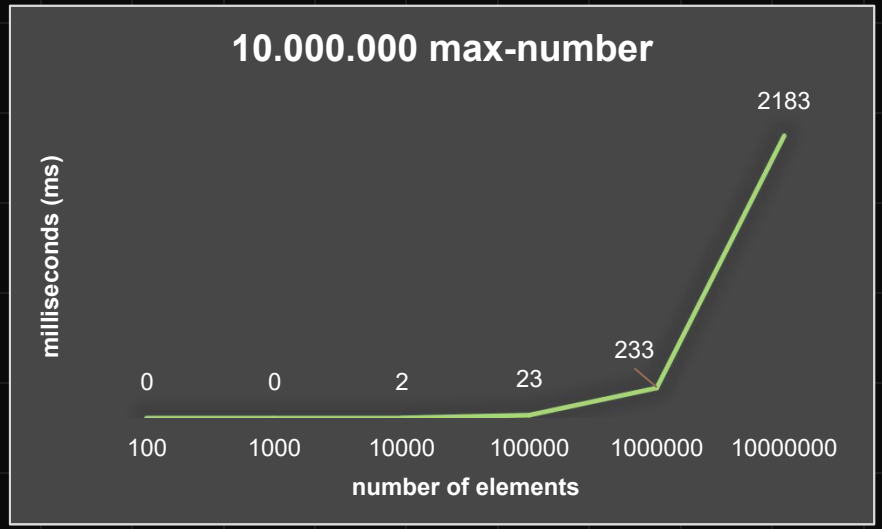
Radix sort

- Based on counting, this algorithm can offer different results based on the base used
- The tests include different bases. It was implemented as a LSD Radix.

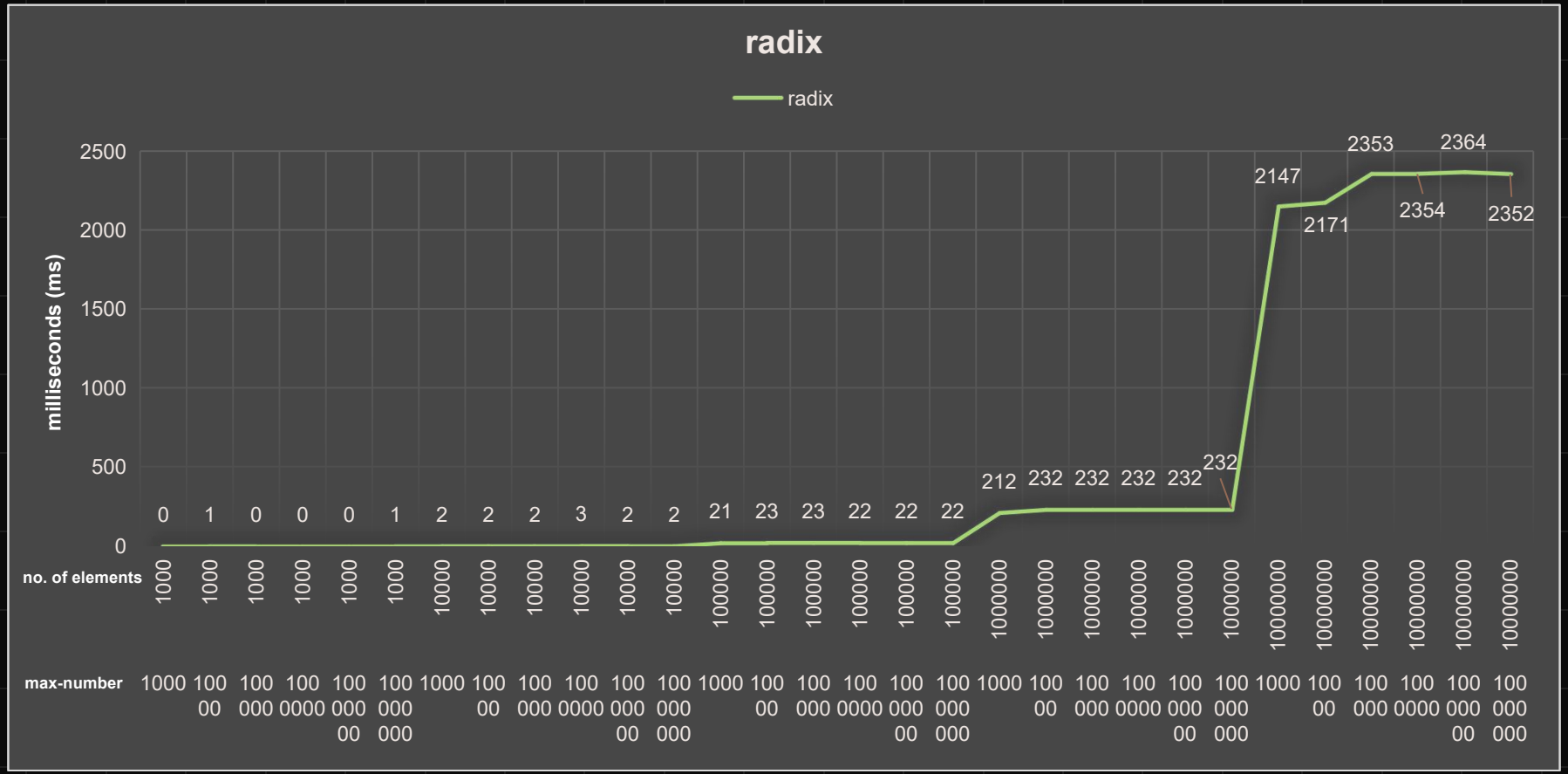
Worst case	Average case	Best case	Memory	Stable
n	n * no_of_digits	n * no_of_digits	$n + 2^{no\_of\_digits}$	yes

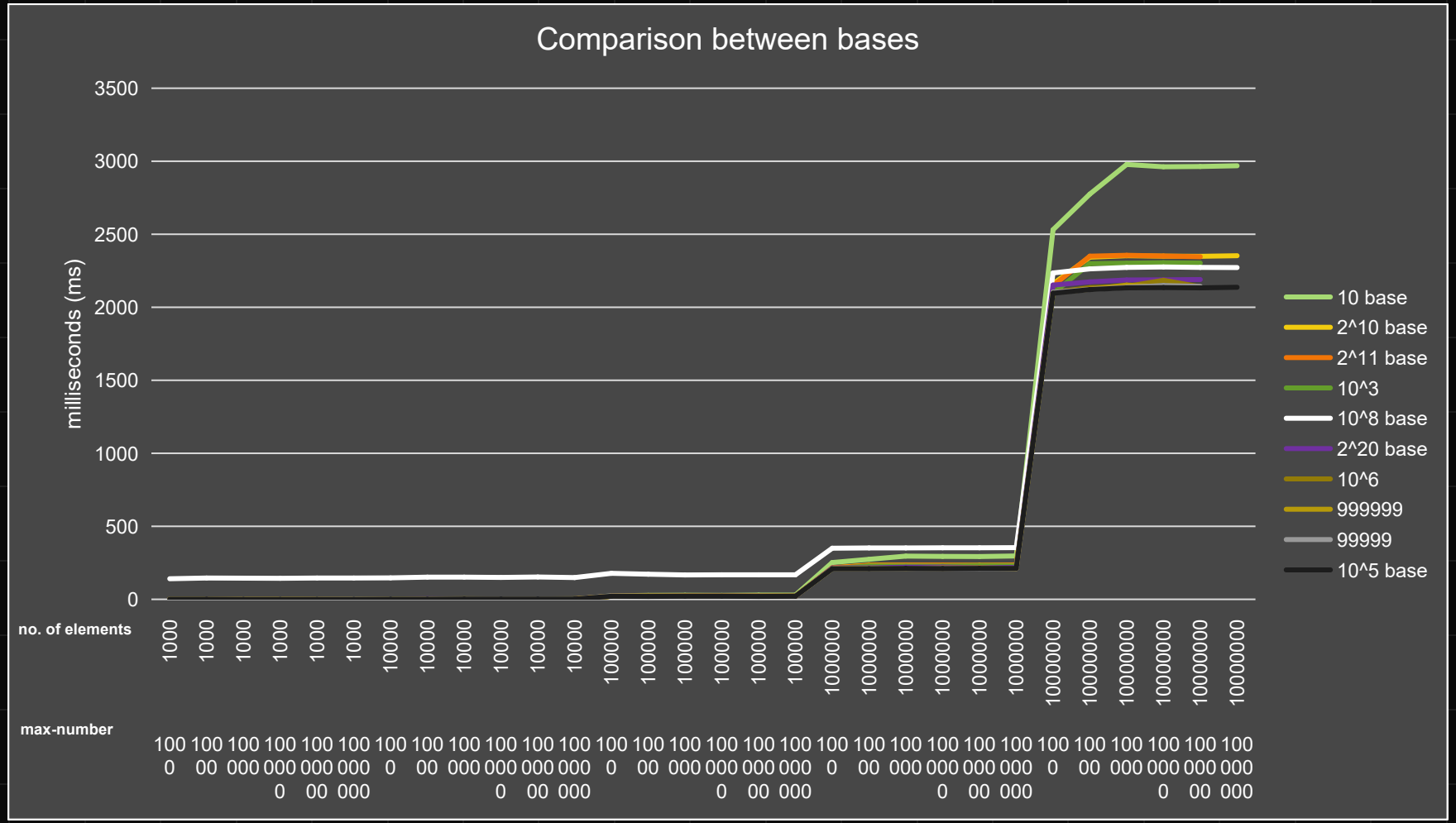
Radix sort





- Here and in the next slide the base raises exponentially from 2^{10} to 2^{15} by 2 on every step


radix
radix
milliseconds (ms)
2500
2000
1500
1000
500
0
0 1 0 0 0 1 2 2 2 3 2 2 21 23 23 22 22 22 212 232 232 232 232 232 2147 2171 2353 2354 2364 2352
no. of elements
1000 1000 1000 1000 1000 1000 10000 10000 10000 10000 10000 10000 100000 100000 100000 100000 100000 100000 1000000 1000000 1000000 1000000 1000000 1000000 10000000 10000000 10000000 10000000 10000000 10000000
max-number
1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000

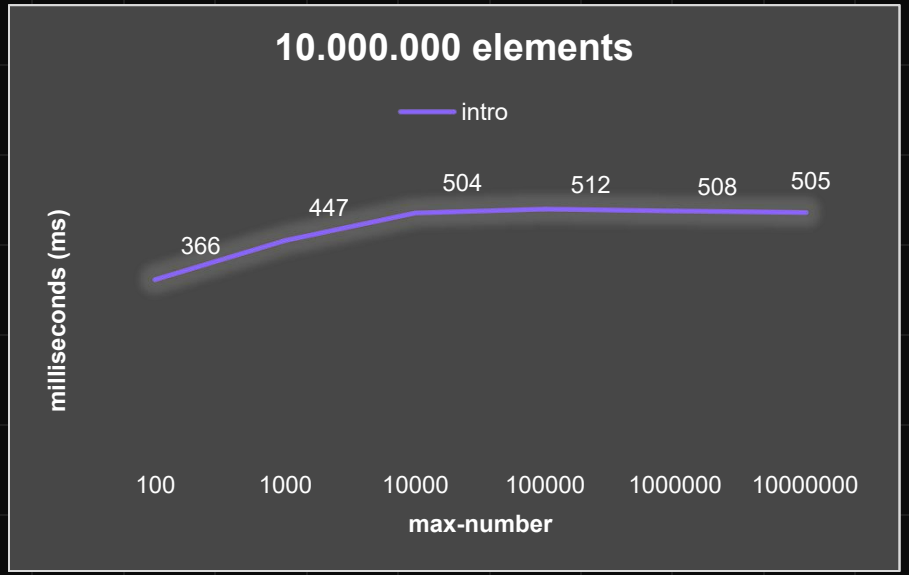

Comparison between bases
milliseconds (ms)
3500
3000
2500
2000
1500
1000
500
0
no. of elements
10000
100000
1000000
10000000
max-number
1000
10000
100000
1000000
10000000
100000000
1000000000
10 base
2^10 base
2^11 base
10^3
10^8 base
2^20 base
10^6
999999
99999
10^5 base

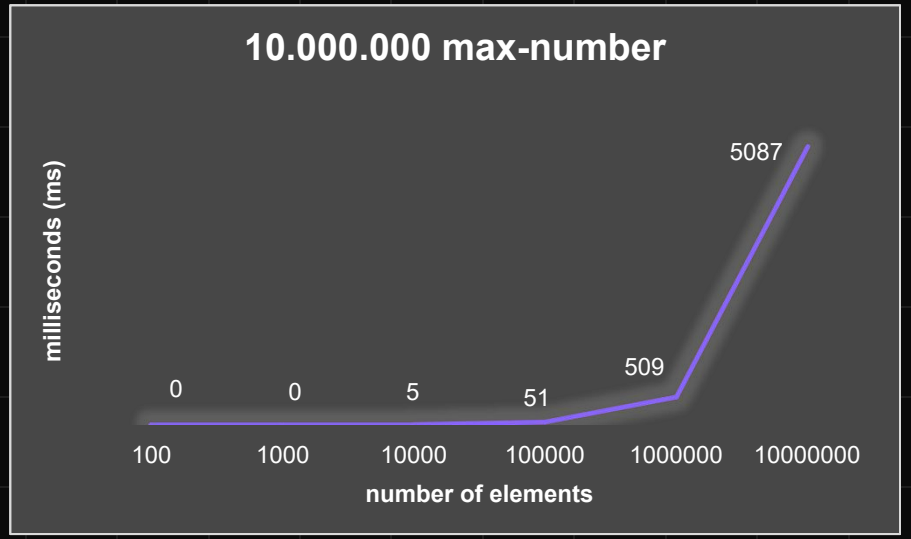
Intro sort

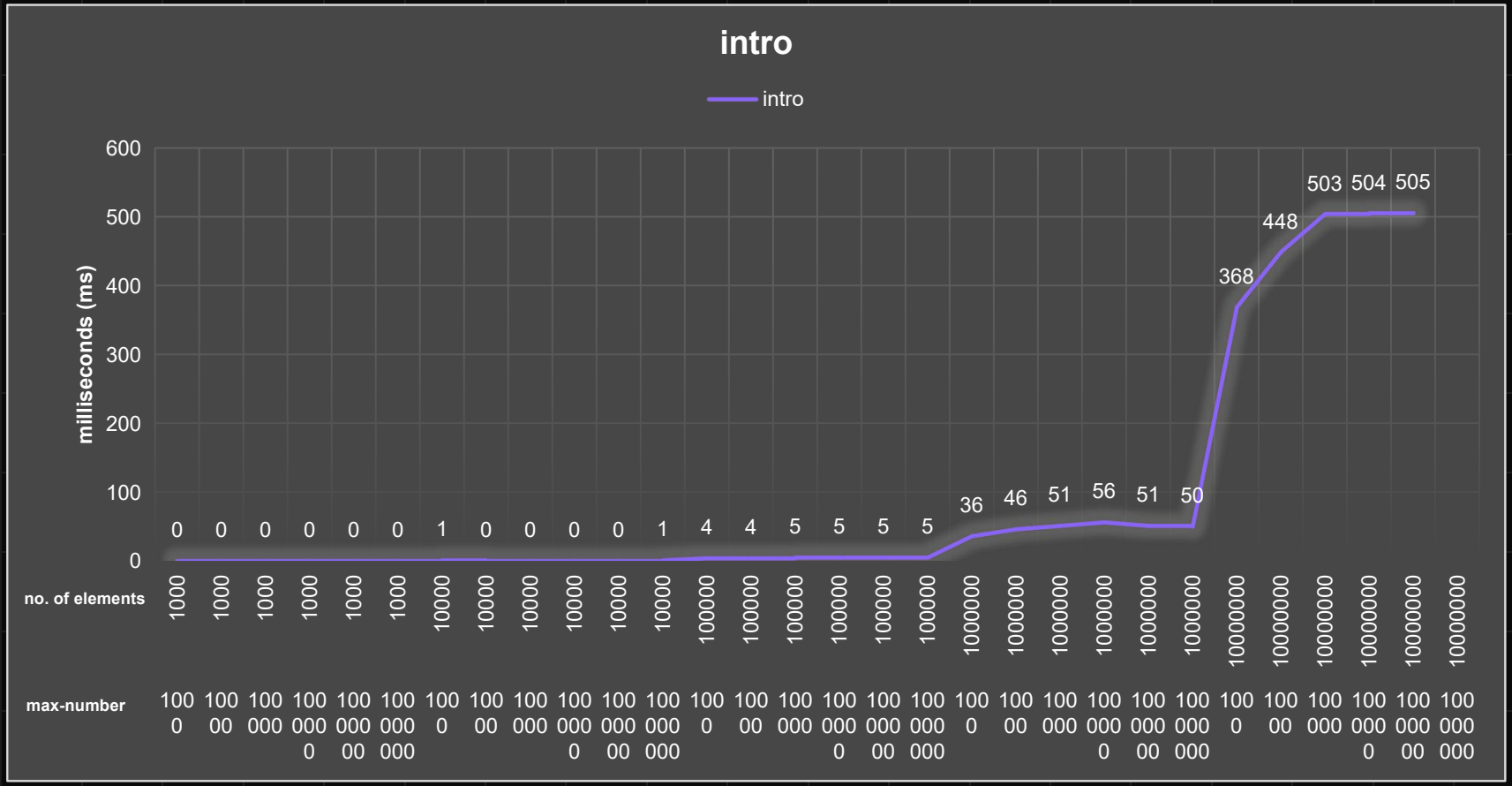
- A hybrid sorting algorithm, used as the standard sorting in C++, which provides both speed and worst-case performance.

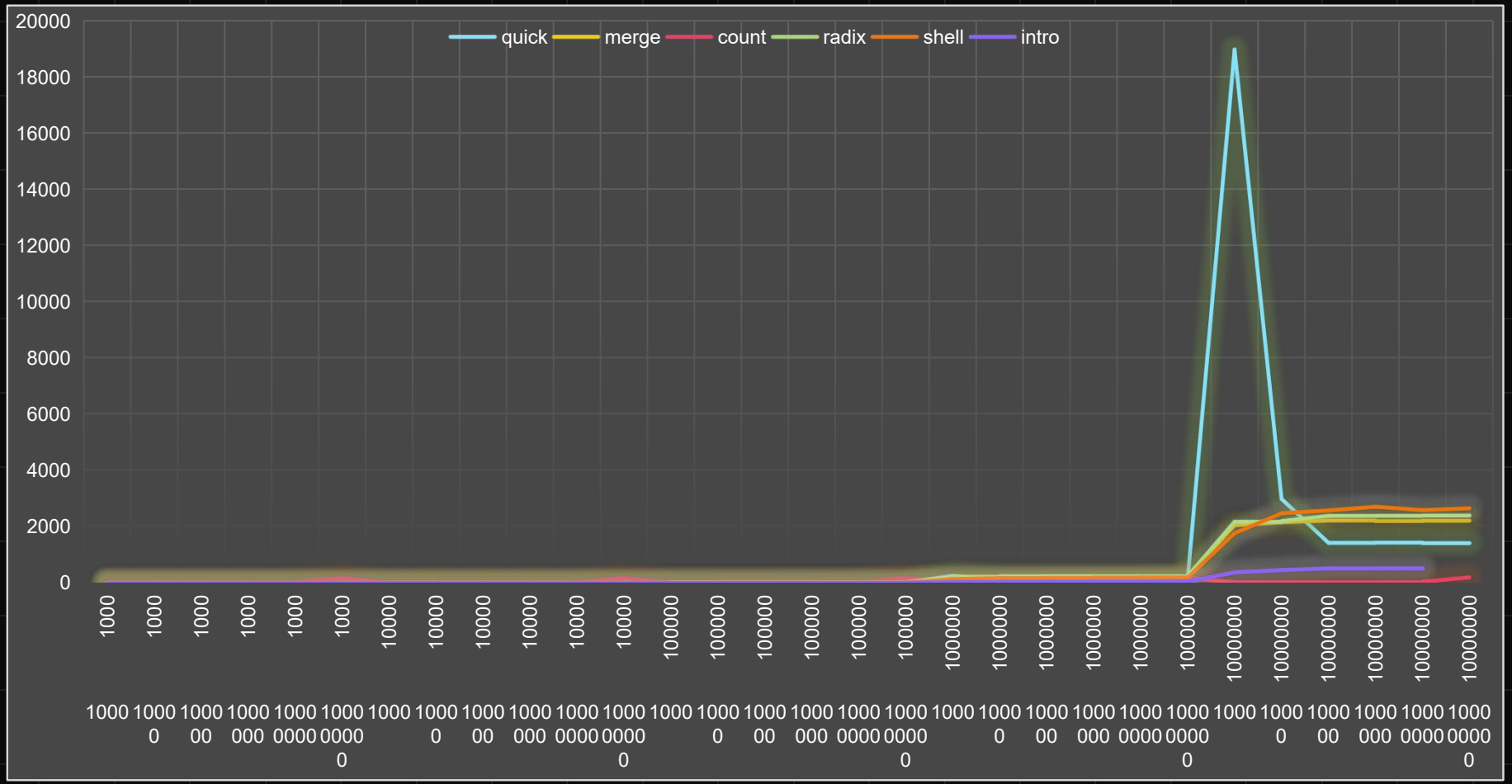
Worst case	Average case	Best case	Memory	Stable
n logn	n logn	n logn	logn	no

Intro sort


10.000.000 elements
intro
milliseconds (ms)
366
447
504
512
508
505
100
1000
10000
100000
1000000
10000000
max-number


10.000.000 max-number
milliseconds (ms)
0
0
5
51
509
5087
100
1000
10000
100000
1000000
10000000
number of elements


intro
intro
600
500
400
300
200
100
0
milliseconds (ms)
0 0 0 0 0 0 1 0 0 0 0 1 4 4 5 5 5 5 36 46 51 56 51 50 368 448 503 504 505
no. of elements
1000 1000 1000 1000 1000 1000 10000 10000 10000 10000 10000 10000 100000 100000 100000 100000 100000 100000 1000000 1000000 1000000 1000000 1000000 1000000 10000000 10000000 10000000 10000000 10000000 10000000
max-number
1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000 1000 10000 100000 1000000 10000000 100000000


quick
merge
count
radix
shell
intro
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1000
1000
1000
1000
1000
1000
10000
10000
10000
10000
10000
10000
100000
100000
100000
100000
100000
100000
1000000
1000000
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1000000
1000000
1000000
10000000
10000000
10000000
10000000
10000000
10000000
1000
10000
100000
1000000
10000000
100000000
1000
10000
100000
1000000
10000000
100000000
1000
10000
100000
1000000
10000000
100000000
1000
10000
100000
1000000
10000000
100000000
1000
10000
100000
1000000
10000000
100000000

Bibliography

https://en.wikipedia.org/wiki/Sorting_algorithm

Thank you for your patience!