QuickSort vs MergeSort

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Comparision of Quicksort and Mergesort

Quicksort has $O(n^2)$ worst-case runtime and O(nlogn) average case runtime. However, it's superior to merge sort in many scenarios because many factors influence an algorithm's runtime, and, when taking them all together, quicksort wins out.

In particular, the often-quoted runtime of sorting algorithms refers to the number of comparisons or the number of swaps necessary to perform to sort the data. This is indeed a good measure of performance, especially since it's independent of the underlying hardware design. However, other things – such as locality of reference (i.e. do we read lots of elements which are probably in cache?) – also play an important role on current hardware. Quicksort in particular requires little additional space and exhibits good cache locality, and this makes it faster than merge sort in many cases.

In addition, it's very easy to avoid quicksort's worst-case run time of O(n2) almost entirely by using an appropriate choice of the pivot – such as picking it at random (this is an excellent strategy).

In practice, many modern implementations of quicksort (in particular libstdc++'s std::sort) are actually introsort, whose theoretical worst-case is O(nlogn), same as merge sort. It achieves this by limiting the recursion depth, and switching to a different algorithm (heapsort) once it exceeds logn.

Results

Comparision Table for Quicksort vs Mergesort

|	$n = 10^2$	$n = 10^3$	$n = 10^4$	$n = 10^5$	$n = 10^6$
Average running time of QuickSort	5.76μs	82.432μs	1.086431ms	13.79606ms	163.201154ms
Average running time of MergeSort	12.3μs	178.59μs	1.99737ms	24.15282ms	293.733225ms
Average number of comparisons in QuickSort	644.946	11002.594	155504.578	2017616.713	2523452.18
Average number of comparisons in MergeSort	542.25	8708.132	120452.184	1536355.955	2114345.23
No of times MergeSort had lesser no of comparisons than QuickSort	992	1000	1000	1000	1000

Table 1: MergeSort and QuickSort Analysis

Quicksort

Time Ranges for Quicksort
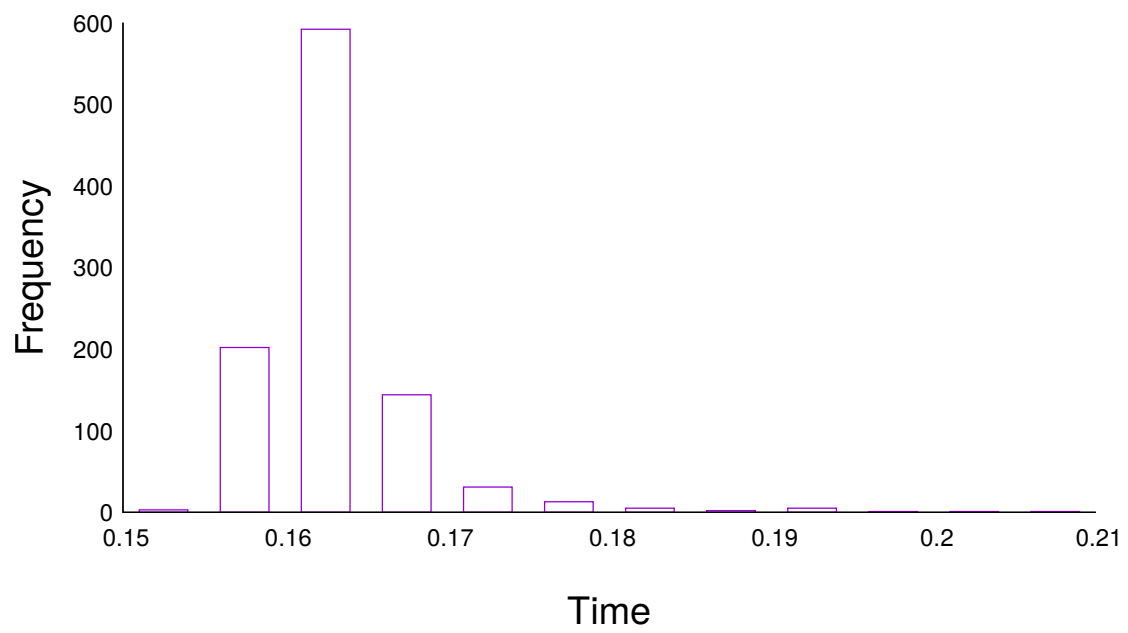
Mergesort

Time Ranges for Mergesort
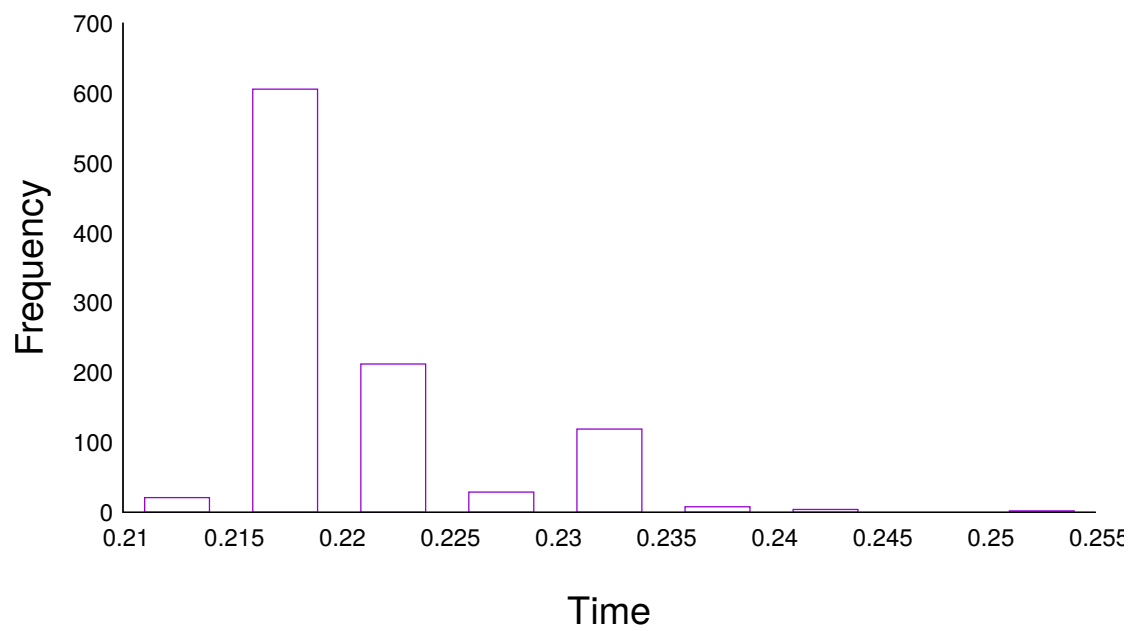
Help taken in building the latex file from [1] and [2]

References

[1] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.

[2] Donald Knuth. Knuth: Computers and typesetting.