|  |  |
| --- | --- |
|  |  |
| **​​Sorting Algorithms Report** | A close up of a logo  Description automatically generated |
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|  | *​​3/10/2024​*  *​​JJ McCauley* |

## Testing Procedure

Using the supercomputing lab, each sorting algorithm was tested in C++ under the same environment. The Chronos library was utilized, and the program tested array sizes of 2-30 million randomly placed integers, incrementing the array size by 2 million each time. Additionally, the program tested for array sizes of 40 and 50 million. Reported is the number of seconds that each program took to execute.

# Results

## Merge Sort:

|  |  |  |
| --- | --- | --- |
|  | | **Time (Seconds)** |
| **Array Size (Millions)** | 2 | 0.205447 |
| 4 | 0.42285 |
| 6 | 0.646809 |
| 8 | 0.883322 |
| 10 | 1.12769 |
| 12 | 1.35284 |
| 14 | 1.60627 |
| 16 | 1.85685 |
| 18 | 2.08293 |
| 20 | 2.3566 |
| 22 | 2.56949 |
| 24 | 2.83543 |
| 26 | 3.0659 |
| 28 | 3.4117 |
| 30 | 3.57975 |
| 40 | 4.85455 |
| 50 | 6.09017 |

## Quick Sort

|  |  |
| --- | --- |
| Array Size | **Time (Seconds)** |
| 2 | 0.15503 |
| 4 | 0.329547 |
| 6 | 0.490358 |
| 8 | 0.660989 |
| 10 | 0.847202 |
| 12 | 1.01492 |
| 14 | 1.21255 |
| 16 | 1.38582 |
| 18 | 1.5592 |
| 20 | 1.7572 |
| 22 | 1.92869 |
| 24 | 2.16742 |
| 26 | 2.33776 |
| 28 | 2.59454 |
| 30 | 2.65984 |
| 40 | 3.65494 |
| 50 | 4.62198 |

## Comb Sort

|  |  |
| --- | --- |
| Array Size | **Time (Seconds)** |
| 2 | 0.295513 |
| 4 | 0.614358 |
| 6 | 0.97119 |
| 8 | 1.33251 |
| 10 | 1.64697 |
| 12 | 1.99864 |
| 14 | 2.36687 |
| 16 | 2.81831 |
| 18 | 3.11726 |
| 20 | 3.42529 |
| 22 | 3.84201 |
| 24 | 4.23085 |
| 26 | 4.55799 |
| 28 | 5.04328 |
| 30 | 5.42774 |
| 40 | 7.57179 |
| 50 | 9.57906 |

## Shell Sort

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.339641 |
| 4 | 0.785058 |
| 6 | 1.27188 |
| 8 | 1.77068 |
| 10 | 2.26546 |
| 12 | 2.8244 |
| 14 | 3.43423 |
| 16 | 3.9939 |
| 18 | 4.69355 |
| 20 | 4.69355 |
| 22 | 6.08207 |
| 24 | 6.6982 |
| 26 | 7.12669 |
| 28 | 7.99511 |
| 30 | 8.6702 |
| 40 | 12.4574 |
| 50 | 16.0675 |

## Heap Sort

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.371251 |
| 4 | 0.78286 |
| 6 | 1.22041 |
| 8 | 1.686 |
| 10 | 2.12439 |
| 12 | 2.62492 |
| 14 | 3.18444 |
| 16 | 3.71469 |
| 18 | 4.4423 |
| 20 | 5.01429 |
| 22 | 5.47384 |
| 24 | 6.1506 |
| 26 | 6.68564 |
| 28 | 7.54023 |
| 30 | 8.04739 |
| 40 | 11.3478 |
| 50 | 14.77 |

## Algorithms Library Sort

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.18074 |
| 4 | 0.377721 |
| 6 | 0.585251 |
| 8 | 0.791366 |
| 10 | 0.999077 |
| 12 | 1.2335 |
| 14 | 1.43552 |
| 16 | 1.6564 |
| 18 | 1.89776 |
| 20 | 2.11404 |
| 22 | 2.31283 |
| 24 | 2.55816 |
| 26 | 2.75484 |
| 28 | 3.04735 |
| 30 | 3.21633 |
| 40 | 4.35758 |
| 50 | 5.47896 |

## Radix Sort

### Radix = 10

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.328343 |
| 4 | 0.663672 |
| 6 | 0.996672 |
| 8 | 1.32504 |
| 10 | 1.68058 |
| 12 | 2.0196 |
| 14 | 2.37121 |
| 16 | 2.76736 |
| 18 | 3.09597 |
| 20 | 3.47499 |
| 22 | 3.7736 |
| 24 | 4.12532 |
| 26 | 4.44321 |
| 28 | 4.89316 |
| 30 | 5.16276 |
| 40 | 6.89415 |
| 50 | 8.64906 |

### Radix = 100

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.168904 |
| 4 | 0.337996 |
| 6 | 0.519681 |
| 8 | 0.671605 |
| 10 | 0.8436 |
| 12 | 1.02435 |
| 14 | 1.21378 |
| 16 | 1.43667 |
| 18 | 1.55134 |
| 20 | 1.73059 |
| 22 | 1.90546 |
| 24 | 2.07854 |
| 26 | 2.29227 |
| 28 | 2.47592 |
| 30 | 2.63022 |
| 40 | 3.50045 |
| 50 | 4.45557 |

### Radix = 1000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.114707 |
| 4 | 0.22904 |
| 6 | 0.345661 |
| 8 | 0.46625 |
| 10 | 0.586185 |
| 12 | 0.709275 |
| 14 | 0.823235 |
| 16 | 0.974423 |
| 18 | 1.07441 |
| 20 | 1.18285 |
| 22 | 1.31411 |
| 24 | 1.43041 |
| 26 | 1.56968 |
| 28 | 1.71634 |
| 30 | 1.84887 |
| 40 | 2.45701 |
| 50 | 3.04537 |

### Radix = 10000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.093581 |
| 4 | 0.1817 |
| 6 | 0.273455 |
| 8 | 0.37129 |
| 10 | 0.456738 |
| 12 | 0.552387 |
| 14 | 0.656706 |
| 16 | 0.751336 |
| 18 | 0.84355 |
| 20 | 0.920376 |
| 22 | 1.03384 |
| 24 | 1.12157 |
| 26 | 1.22374 |
| 28 | 1.32926 |
| 30 | 1.43152 |
| 40 | 1.90801 |
| 50 | 2.3917 |

### Radix = 10 & Range of 0-1000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.05631 |
| 4 | 0.113109 |
| 6 | 0.170899 |
| 8 | 0.230786 |
| 10 | 0.285372 |
| 12 | 0.343415 |
| 14 | 0.404602 |
| 16 | 0.469659 |
| 18 | 0.525353 |
| 20 | 0.589208 |
| 22 | 0.649764 |
| 24 | 0.714684 |
| 26 | 0.769982 |
| 28 | 0.834126 |
| 30 | 0.886414 |
| 40 | 1.19848 |
| 50 | 1.48831 |

### Radix = 100 & Range of 0-1000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.029852 |
| 4 | 0.060032 |
| 6 | 0.089019 |
| 8 | 0.120805 |
| 10 | 0.152742 |
| 12 | 0.17951 |
| 14 | 0.209124 |
| 16 | 0.245067 |
| 18 | 0.276168 |
| 20 | 0.305708 |
| 22 | 0.342969 |
| 24 | 0.364786 |
| 26 | 0.399994 |
| 28 | 0.441176 |
| 30 | 0.477565 |
| 40 | 0.629783 |
| 50 | 0.800192 |

### Radix = 1000 & Range of 0-1000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.029795 |
| 4 | 0.059524 |
| 6 | 0.090379 |
| 8 | 0.121376 |
| 10 | 0.156999 |
| 12 | 0.182427 |
| 14 | 0.210719 |
| 16 | 0.25004 |
| 18 | 0.2763 |
| 20 | 0.304426 |
| 22 | 0.348079 |
| 24 | 0.380921 |
| 26 | 0.407427 |
| 28 | 0.433091 |
| 30 | 0.475463 |
| 40 | 0.640244 |
| 50 | 0.806392 |

### Radix = 10000 & Range of 0-1000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.009029 |
| 4 | 0.019258 |
| 6 | 0.020652 |
| 8 | 0.027753 |
| 10 | 0.03507 |
| 12 | 0.041735 |
| 14 | 0.049547 |
| 16 | 0.055452 |
| 18 | 0.063533 |
| 20 | 0.07886 |
| 22 | 0.0799 |
| 24 | 0.082575 |
| 26 | 0.091527 |
| 28 | 0.096291 |
| 30 | 0.106715 |
| 40 | 0.1393 |
| 50 | 0.173355 |

### Radix = 10000 & Range of 0-1000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.009029 |
| 4 | 0.019258 |
| 6 | 0.020652 |
| 8 | 0.027753 |
| 10 | 0.03507 |
| 12 | 0.041735 |
| 14 | 0.049547 |
| 16 | 0.055452 |
| 18 | 0.063533 |
| 20 | 0.07886 |
| 22 | 0.0799 |
| 24 | 0.082575 |
| 26 | 0.091527 |
| 28 | 0.096291 |
| 30 | 0.106715 |
| 40 | 0.1393 |
| 50 | 0.173355 |

## Count Sort

### No Maximum Range

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 2.87916 |
| 4 | 2.91073 |
| 6 | 2.9777 |
| 8 | 2.94196 |
| 10 | 3.1065 |
| 12 | 3.15106 |
| 14 | 3.21413 |
| 16 | 3.24552 |
| 18 | 3.47202 |
| 20 | 3.44361 |
| 22 | 3.40094 |
| 24 | 3.55683 |
| 26 | 3.61067 |
| 28 | 3.63299 |
| 30 | 3.73324 |
| 40 | 3.98236 |
| 50 | 4.29681 |

### Range of 0-1000

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.056881 |
| 4 | 0.112364 |
| 6 | 0.170565 |
| 8 | 0.224802 |
| 10 | 0.282357 |
| 12 | 0.337148 |
| 14 | 0.392274 |
| 16 | 0.451291 |
| 18 | 0.515964 |
| 20 | 0.574087 |
| 22 | 0.627522 |
| 24 | 0.683244 |
| 26 | 0.740838 |
| 28 | 0.801273 |
| 30 | 0.852025 |
| 40 | 1.1458 |
| 50 | 1.43301 |

## Bucket Sort

|  |  |
| --- | --- |
| n | **Time (Seconds)** |
| 2 | 0.056881 |
| 4 | 0.112364 |
| 6 | 0.170565 |
| 8 | 0.224802 |
| 10 | 0.282357 |
| 12 | 0.337148 |
| 14 | 0.392274 |
| 16 | 0.451291 |
| 18 | 0.515964 |
| 20 | 0.574087 |
| 22 | 0.627522 |
| 24 | 0.683244 |
| 26 | 0.740838 |
| 28 | 0.801273 |
| 30 | 0.852025 |
| 40 | 1.1458 |
| 50 | 1.43301 |

# Conclusions