Merge Sort:

Merge sort is an efficient sorting algorithm with a complexity of **n*log(n)**. It splits a dataset into two smaller left and right data sets, and continues recursively until there are multiple subsets only containing one item each. It then merges these sets into a sorted list.

It is important to note that this sorting algorithm uses recursion, which is a unique feature of it.

Heap Sort:

Heap sort is an efficient sorting algorithm with a complexity of **n*log(n)**. It is a similar algorithm to selection sort, but uses a different data structure that vastly improves performance. It divides the data set into two regions: sorted and unsorted. It slowly pares the unsorted data by selecting the largest element and moving it over the the sorted side. Keeping the unsorted region in a heap data structure allows this implementation to efficiently find the largest element contrary to Selection Sort.

Selection Sort:

Selection sort is a simple sorting algorithm with a complexity of **O(n^2)**. It selects the smallest (or largest) element from the data set and replaces the first element in the array with it. Then, we find the next smallest element, and replace the second element with it. This continues until the set is sorted.

Selection sort is weak in that the larger the data set is, the longer it takes, as it has O(n^2) complexity. It can work well with smaller data sets. It can also be implemented very easily.

Insertion Sort:

Insertion sort is a simple sorting algorithm with a complexity of **O(n^2).** It works by selecting the element after the last sorted item in the set, and then comparing it against the sorted elements to find its position. For instance, it starts by comparing the first and second elements in the list, and will swap them if the second element is less than the first. Then, it will compare the third element in the list against the first and second element to decide its placement.

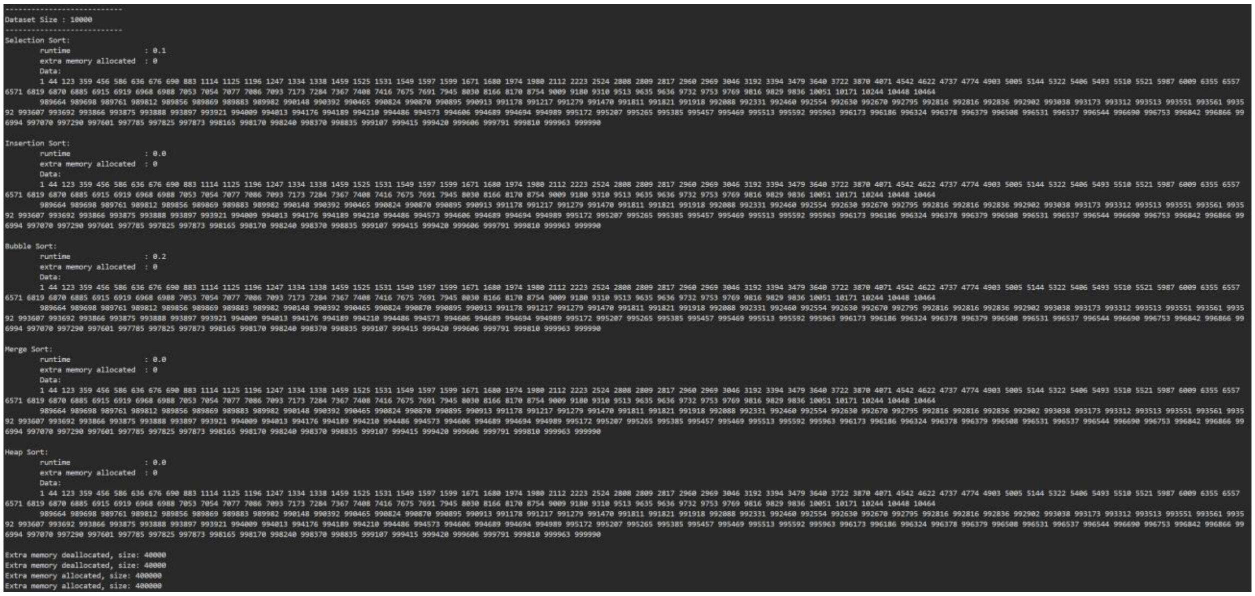
Insertion sort is more efficient than selection sort or bubble sort in most cases. It is also efficient for small data sets. It can be implemented with relative ease- with some implementations even being 3-5 lines long. It is the most efficient sorting algorithm of the quadratic ones (bubble, insertion, selection.)

Bubble Sort:

Bubble sort is a very simple sorting algorithm with a complexity of **N^2**. It loops through the data set, comparing each adjacent element against each other and swapping them if they are in an unsorted order. It is very simple and easily implemented.

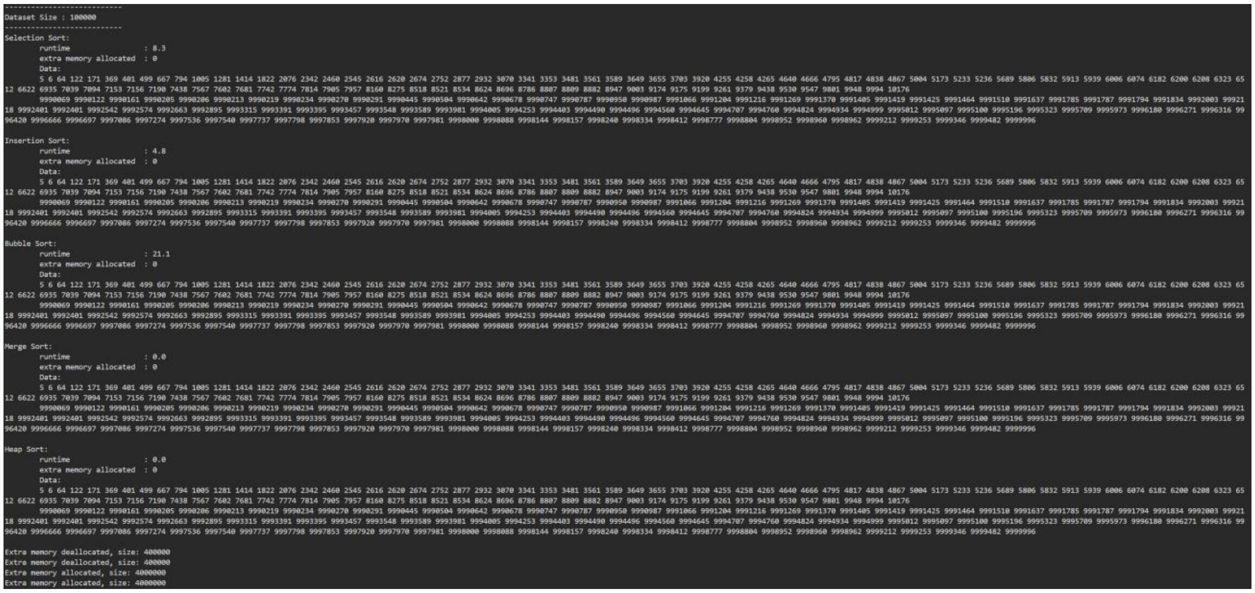
It is important to note that it will very quickly lose efficiency as elements are added. Not suitable for large data sets. It is the least efficient sorting algorithm.

Output 1:



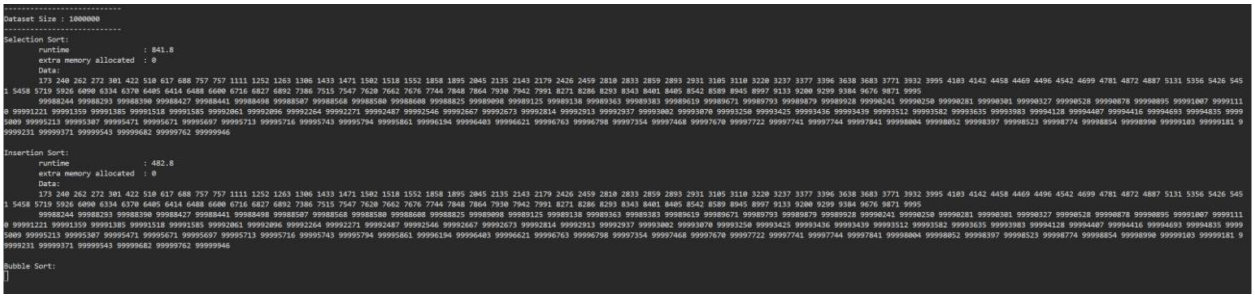
```
---------------------------
Dataset Size : 10000
---------------------------
Selection Sort:
        runtime                 : 0.1
        extra memory allocated  : 0
        Data:
        1 44 123 359 456 586 636 676 690 883 1114 1125 1196 1247 1334 1338 1459 1525 1531 1549 1597 1599 1671 1680 1974 1980 2112 2223 2524 2808 2809 2817 2960 2969 3046 3192 3394 3479 3640 3722 3870 4071 4542 4622 4737 4774 4903 5005 5144 5322 5406 5493 5510 5521 5987 6009 6355 6557
6571 6819 6870 6885 6915 6919 6968 6988 7053 7054 7077 7086 7093 7173 7284 7367 7408 7416 7675 7691 7945 8030 8166 8170 8754 9009 9180 9310 9513 9635 9636 9732 9753 9769 9816 9829 9836 10051 10171 10244 10448 10464
        989664 989698 989761 989812 989856 989869 989883 989982 990148 990392 990465 990824 990870 990895 990913 991178 991217 991279 991470 991811 991821 991918 992088 992331 992460 992554 992630 992670 992795 992816 992816 992836 992902 993038 993173 993312 993513 993551 993561 9935
92 993607 993692 993866 993875 993888 993897 993921 994009 994013 994176 994189 994210 994486 994573 994606 994689 994694 994989 995172 995207 995265 995385 995457 995469 995513 995592 995963 996173 996186 996324 996378 996379 996508 996531 996537 996544 996690 996753 996842 996866 99
6994 997070 997290 997601 997785 997825 997873 998165 998170 998240 998370 998835 999107 999415 999420 999606 999791 999810 999963 999990

Insertion Sort:
        runtime                 : 0.0
        extra memory allocated  : 0
        Data:
        1 44 123 359 456 586 636 676 690 883 1114 1125 1196 1247 1334 1338 1459 1525 1531 1549 1597 1599 1671 1680 1974 1980 2112 2223 2524 2808 2809 2817 2960 2969 3046 3192 3394 3479 3640 3722 3870 4071 4542 4622 4737 4774 4903 5005 5144 5322 5406 5493 5510 5521 5987 6009 6355 6557
6571 6819 6870 6885 6915 6919 6968 6988 7053 7054 7077 7086 7093 7173 7284 7367 7408 7416 7675 7691 7945 8030 8166 8170 8754 9009 9180 9310 9513 9635 9636 9732 9753 9769 9816 9829 9836 10051 10171 10244 10448 10464
        989664 989698 989761 989812 989856 989869 989883 989982 990148 990392 990465 990824 990870 990895 990913 991178 991217 991279 991470 991811 991821 991918 992088 992331 992460 992554 992630 992670 992795 992816 992816 992836 992902 993038 993173 993312 993513 993551 993561 9935
92 993607 993692 993866 993875 993888 993897 993921 994009 994013 994176 994189 994210 994486 994573 994606 994689 994694 994989 995172 995207 995265 995385 995457 995469 995513 995592 995963 996173 996186 996324 996378 996379 996508 996531 996537 996544 996690 996753 996842 996866 99
6994 997070 997290 997601 997785 997825 997873 998165 998170 998240 998370 998835 999107 999415 999420 999606 999791 999810 999963 999990

Bubble Sort:
        runtime                 : 0.2
        extra memory allocated  : 0
        Data:
        1 44 123 359 456 586 636 676 690 883 1114 1125 1196 1247 1334 1338 1459 1525 1531 1549 1597 1599 1671 1680 1974 1980 2112 2223 2524 2808 2809 2817 2960 2969 3046 3192 3394 3479 3640 3722 3870 4071 4542 4622 4737 4774 4903 5005 5144 5322 5406 5493 5510 5521 5987 6009 6355 6557
6571 6819 6870 6885 6915 6919 6968 6988 7053 7054 7077 7086 7093 7173 7284 7367 7408 7416 7675 7691 7945 8030 8166 8170 8754 9009 9180 9310 9513 9635 9636 9732 9753 9769 9816 9829 9836 10051 10171 10244 10448 10464
        989664 989698 989761 989812 989856 989869 989883 989982 990148 990392 990465 990824 990870 990895 990913 991178 991217 991279 991470 991811 991821 991918 992088 992331 992460 992554 992630 992670 992795 992816 992816 992836 992902 993038 993173 993312 993513 993551 993561 9935
92 993607 993692 993866 993875 993888 993897 993921 994009 994013 994176 994189 994210 994486 994573 994606 994689 994694 994989 995172 995207 995265 995385 995457 995469 995513 995592 995963 996173 996186 996324 996378 996379 996508 996531 996537 996544 996690 996753 996842 996866 99
6994 997070 997290 997601 997785 997825 997873 998165 998170 998240 998370 998835 999107 999415 999420 999606 999791 999810 999963 999990

Merge Sort:
        runtime                 : 0.0
        extra memory allocated  : 0
        Data:
        1 44 123 359 456 586 636 676 690 883 1114 1125 1196 1247 1334 1338 1459 1525 1531 1549 1597 1599 1671 1680 1974 1980 2112 2223 2524 2808 2809 2817 2960 2969 3046 3192 3394 3479 3640 3722 3870 4071 4542 4622 4737 4774 4903 5005 5144 5322 5406 5493 5510 5521 5987 6009 6355 6557
6571 6819 6870 6885 6915 6919 6968 6988 7053 7054 7077 7086 7093 7173 7284 7367 7408 7416 7675 7691 7945 8030 8166 8170 8754 9009 9180 9310 9513 9635 9636 9732 9753 9769 9816 9829 9836 10051 10171 10244 10448 10464
        989664 989698 989761 989812 989856 989869 989883 989982 990148 990392 990465 990824 990870 990895 990913 991178 991217 991279 991470 991811 991821 991918 992088 992331 992460 992554 992630 992670 992795 992816 992816 992836 992902 993038 993173 993312 993513 993551 993561 9935
92 993607 993692 993866 993875 993888 993897 993921 994009 994013 994176 994189 994210 994486 994573 994606 994689 994694 994989 995172 995207 995265 995385 995457 995469 995513 995592 995963 996173 996186 996324 996378 996379 996508 996531 996537 996544 996690 996753 996842 996866 99
6994 997070 997290 997601 997785 997825 997873 998165 998170 998240 998370 998835 999107 999415 999420 999606 999791 999810 999963 999990

Heap Sort:
        runtime                 : 0.0
        extra memory allocated  : 0
        Data:
        1 44 123 359 456 586 636 676 690 883 1114 1125 1196 1247 1334 1338 1459 1525 1531 1549 1597 1599 1671 1680 1974 1980 2112 2223 2524 2808 2809 2817 2960 2969 3046 3192 3394 3479 3640 3722 3870 4071 4542 4622 4737 4774 4903 5005 5144 5322 5406 5493 5510 5521 5987 6009 6355 6557
6571 6819 6870 6885 6915 6919 6968 6988 7053 7054 7077 7086 7093 7173 7284 7367 7408 7416 7675 7691 7945 8030 8166 8170 8754 9009 9180 9310 9513 9635 9636 9732 9753 9769 9816 9829 9836 10051 10171 10244 10448 10464
        989664 989698 989761 989812 989856 989869 989883 989982 990148 990392 990465 990824 990870 990895 990913 991178 991217 991279 991470 991811 991821 991918 992088 992331 992460 992554 992630 992670 992795 992816 992816 992836 992902 993038 993173 993312 993513 993551 993561 9935
92 993607 993692 993866 993875 993888 993897 993921 994009 994013 994176 994189 994210 994486 994573 994606 994689 994694 994989 995172 995207 995265 995385 995457 995469 995513 995592 995963 996173 996186 996324 996378 996379 996508 996531 996537 996544 996690 996753 996842 996866 99
6994 997070 997290 997601 997785 997825 997873 998165 998170 998240 998370 998835 999107 999415 999420 999606 999791 999810 999963 999990

Extra memory deallocated, size: 40000
Extra memory deallocated, size: 40000
Extra memory allocated, size: 400000
Extra memory allocated, size: 400000
```

Output 2:



```
---------------------------
Dataset Size : 100000
---------------------------
Selection Sort:
        runtime                 : 8.3
        extra memory allocated  : 0
        Data:
        5 6 64 122 171 369 401 499 667 794 1005 1281 1414 1822 2076 2342 2460 2545 2616 2620 2674 2752 2877 2932 3070 3341 3353 3481 3561 3589 3649 3655 3703 3920 4255 4258 4265 4640 4666 4795 4817 4838 4867 5004 5173 5233 5236 5689 5806 5832 5913 5939 6006 6074 6182 6200 6208 6323 65
12 6622 6935 7039 7094 7153 7156 7190 7438 7567 7602 7681 7742 7774 7814 7905 7957 8160 8275 8518 8521 8534 8624 8696 8786 8807 8809 8882 8947 9003 9174 9175 9199 9261 9379 9438 9530 9547 9801 9948 9994 10176
        9990069 9990122 9990161 9990205 9990206 9990213 9990219 9990234 9990270 9990291 9990445 9990504 9990642 9990678 9990747 9990787 9990950 9990987 9991066 9991204 9991216 9991269 9991370 9991405 9991419 9991425 9991464 9991510 9991637 9991785 9991787 9991794 9991834 9992003 99921
18 9992401 9992401 9992542 9992574 9992663 9992895 9993315 9993391 9993395 9993457 9993548 9993589 9993981 9994005 9994253 9994403 9994490 9994496 9994560 9994645 9994707 9994760 9994824 9994934 9994999 9995012 9995097 9995100 9995196 9995323 9995709 9995973 9996180 9996271 9996316 99
96420 9996666 9996697 9997086 9997274 9997536 9997540 9997737 9997798 9997853 9997920 9997970 9997981 9998000 9998088 9998144 9998157 9998240 9998334 9998412 9998777 9998804 9998952 9998960 9998962 9999212 9999253 9999346 9999482 9999996

Insertion Sort:
        runtime                 : 4.8
        extra memory allocated  : 0
        Data:
        5 6 64 122 171 369 401 499 667 794 1005 1281 1414 1822 2076 2342 2460 2545 2616 2620 2674 2752 2877 2932 3070 3341 3353 3481 3561 3589 3649 3655 3703 3920 4255 4258 4265 4640 4666 4795 4817 4838 4867 5004 5173 5233 5236 5689 5806 5832 5913 5939 6006 6074 6182 6200 6208 6323 65
12 6622 6935 7039 7094 7153 7156 7190 7438 7567 7602 7681 7742 7774 7814 7905 7957 8160 8275 8518 8521 8534 8624 8696 8786 8807 8809 8882 8947 9003 9174 9175 9199 9261 9379 9438 9530 9547 9801 9948 9994 10176
        9990069 9990122 9990161 9990205 9990206 9990213 9990219 9990234 9990270 9990291 9990445 9990504 9990642 9990678 9990747 9990787 9990950 9990987 9991066 9991204 9991216 9991269 9991370 9991405 9991419 9991425 9991464 9991510 9991637 9991785 9991787 9991794 9991834 9992003 99921
18 9992401 9992401 9992542 9992574 9992663 9992895 9993315 9993391 9993395 9993457 9993548 9993589 9993981 9994005 9994253 9994403 9994490 9994496 9994560 9994645 9994707 9994760 9994824 9994934 9994999 9995012 9995097 9995100 9995196 9995323 9995709 9995973 9996180 9996271 9996316 99
96420 9996666 9996697 9997086 9997274 9997536 9997540 9997737 9997798 9997853 9997920 9997970 9997981 9998000 9998088 9998144 9998157 9998240 9998334 9998412 9998777 9998804 9998952 9998960 9998962 9999212 9999253 9999346 9999482 9999996

Bubble Sort:
        runtime                 : 21.1
        extra memory allocated  : 0
        Data:
        5 6 64 122 171 369 401 499 667 794 1005 1281 1414 1822 2076 2342 2460 2545 2616 2620 2674 2752 2877 2932 3070 3341 3353 3481 3561 3589 3649 3655 3703 3920 4255 4258 4265 4640 4666 4795 4817 4838 4867 5004 5173 5233 5236 5689 5806 5832 5913 5939 6006 6074 6182 6200 6208 6323 65
12 6622 6935 7039 7094 7153 7156 7190 7438 7567 7602 7681 7742 7774 7814 7905 7957 8160 8275 8518 8521 8534 8624 8696 8786 8807 8809 8882 8947 9003 9174 9175 9199 9261 9379 9438 9530 9547 9801 9948 9994 10176
        9990069 9990122 9990161 9990205 9990206 9990213 9990219 9990234 9990270 9990291 9990445 9990504 9990642 9990678 9990747 9990787 9990950 9990987 9991066 9991204 9991216 9991269 9991370 9991405 9991419 9991425 9991464 9991510 9991637 9991785 9991787 9991794 9991834 9992003 99921
18 9992401 9992401 9992542 9992574 9992663 9992895 9993315 9993391 9993395 9993457 9993548 9993589 9993981 9994005 9994253 9994403 9994490 9994496 9994560 9994645 9994707 9994760 9994824 9994934 9994999 9995012 9995097 9995100 9995196 9995323 9995709 9995973 9996180 9996271 9996316 99
96420 9996666 9996697 9997086 9997274 9997536 9997540 9997737 9997798 9997853 9997920 9997970 9997981 9998000 9998088 9998144 9998157 9998240 9998334 9998412 9998777 9998804 9998952 9998960 9998962 9999212 9999253 9999346 9999482 9999996

Merge Sort:
        runtime                 : 0.0
        extra memory allocated  : 0
        Data:
        5 6 64 122 171 369 401 499 667 794 1005 1281 1414 1822 2076 2342 2460 2545 2616 2620 2674 2752 2877 2932 3070 3341 3353 3481 3561 3589 3649 3655 3703 3920 4255 4258 4265 4640 4666 4795 4817 4838 4867 5004 5173 5233 5236 5689 5806 5832 5913 5939 6006 6074 6182 6200 6208 6323 65
12 6622 6935 7039 7094 7153 7156 7190 7438 7567 7602 7681 7742 7774 7814 7905 7957 8160 8275 8518 8521 8534 8624 8696 8786 8807 8809 8882 8947 9003 9174 9175 9199 9261 9379 9438 9530 9547 9801 9948 9994 10176
        9990069 9990122 9990161 9990205 9990206 9990213 9990219 9990234 9990270 9990291 9990445 9990504 9990642 9990678 9990747 9990787 9990950 9990987 9991066 9991204 9991216 9991269 9991370 9991405 9991419 9991425 9991464 9991510 9991637 9991785 9991787 9991794 9991834 9992003 99921
18 9992401 9992401 9992542 9992574 9992663 9992895 9993315 9993391 9993395 9993457 9993548 9993589 9993981 9994005 9994253 9994403 9994490 9994496 9994560 9994645 9994707 9994760 9994824 9994934 9994999 9995012 9995097 9995100 9995196 9995323 9995709 9995973 9996180 9996271 9996316 99
96420 9996666 9996697 9997086 9997274 9997536 9997540 9997737 9997798 9997853 9997920 9997970 9997981 9998000 9998088 9998144 9998157 9998240 9998334 9998412 9998777 9998804 9998952 9998960 9998962 9999212 9999253 9999346 9999482 9999996

Heap Sort:
        runtime                 : 0.0
        extra memory allocated  : 0
        Data:
        5 6 64 122 171 369 401 499 667 794 1005 1281 1414 1822 2076 2342 2460 2545 2616 2620 2674 2752 2877 2932 3070 3341 3353 3481 3561 3589 3649 3655 3703 3920 4255 4258 4265 4640 4666 4795 4817 4838 4867 5004 5173 5233 5236 5689 5806 5832 5913 5939 6006 6074 6182 6200 6208 6323 65
12 6622 6935 7039 7094 7153 7156 7190 7438 7567 7602 7681 7742 7774 7814 7905 7957 8160 8275 8518 8521 8534 8624 8696 8786 8807 8809 8882 8947 9003 9174 9175 9199 9261 9379 9438 9530 9547 9801 9948 9994 10176
        9990069 9990122 9990161 9990205 9990206 9990213 9990219 9990234 9990270 9990291 9990445 9990504 9990642 9990678 9990747 9990787 9990950 9990987 9991066 9991204 9991216 9991269 9991370 9991405 9991419 9991425 9991464 9991510 9991637 9991785 9991787 9991794 9991834 9992003 99921
18 9992401 9992401 9992542 9992574 9992663 9992895 9993315 9993391 9993395 9993457 9993548 9993589 9993981 9994005 9994253 9994403 9994490 9994496 9994560 9994645 9994707 9994760 9994824 9994934 9994999 9995012 9995097 9995100 9995196 9995323 9995709 9995973 9996180 9996271 9996316 99
96420 9996666 9996697 9997086 9997274 9997536 9997540 9997737 9997798 9997853 9997920 9997970 9997981 9998000 9998088 9998144 9998157 9998240 9998334 9998412 9998777 9998804 9998952 9998960 9998962 9999212 9999253 9999346 9999482 9999996

Extra memory deallocated, size: 400000
Extra memory deallocated, size: 400000
Extra memory allocated, size: 4000000
Extra memory allocated, size: 4000000
```

Output 3:



```
---------------------------
Dataset Size : 1000000
---------------------------
Selection Sort:
        runtime                 : 841.8
        extra memory allocated  : 0
        Data:
        173 240 262 272 301 422 510 617 688 757 757 1111 1252 1263 1306 1433 1471 1502 1518 1552 1858 1895 2045 2135 2143 2179 2426 2459 2810 2833 2859 2893 2931 3105 3110 3220 3237 3377 3396 3638 3683 3771 3932 3995 4103 4142 4458 4469 4496 4542 4699 4781 4872 4887 5131 5356 5426 545
1 5458 5719 5926 6090 6334 6370 6405 6414 6488 6600 6716 6827 6892 7386 7515 7547 7620 7662 7676 7744 7848 7864 7930 7942 7991 8271 8286 8293 8343 8401 8405 8542 8589 8945 8997 9133 9200 9299 9384 9676 9871 9995
        99988244 99988293 99988390 99988427 99988441 99988498 99988507 99988568 99988580 99988608 99988825 99989098 99989125 99989138 99989363 99989383 99989619 99989671 99989793 99989879 99989928 99990241 99990250 99990281 99990301 99990327 99990528 99990878 99990895 99991007 9999111
0 99991221 99991359 99991385 99991518 99991585 99992061 99992096 99992264 99992271 99992487 99992546 99992667 99992673 99992814 99992913 99992937 99993002 99993070 99993250 99993425 99993436 99993439 99993512 99993582 99993635 99993983 99994128 99994407 99994416 99994693 99994835 9999
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9999231 99999371 99999543 99999682 99999762 99999946

Insertion Sort:
        runtime                 : 482.8
        extra memory allocated  : 0
        Data:
        173 240 262 272 301 422 510 617 688 757 757 1111 1252 1263 1306 1433 1471 1502 1518 1552 1858 1895 2045 2135 2143 2179 2426 2459 2810 2833 2859 2893 2931 3105 3110 3220 3237 3377 3396 3638 3683 3771 3932 3995 4103 4142 4458 4469 4496 4542 4699 4781 4872 4887 5131 5356 5426 545
1 5458 5719 5926 6090 6334 6370 6405 6414 6488 6600 6716 6827 6892 7386 7515 7547 7620 7662 7676 7744 7848 7864 7930 7942 7991 8271 8286 8293 8343 8401 8405 8542 8589 8945 8997 9133 9200 9299 9384 9676 9871 9995
        99988244 99988293 99988390 99988427 99988441 99988498 99988507 99988568 99988580 99988608 99988825 99989098 99989125 99989138 99989363 99989383 99989619 99989671 99989793 99989879 99989928 99990241 99990250 99990281 99990301 99990327 99990528 99990878 99990895 99991007 9999111
0 99991221 99991359 99991385 99991518 99991585 99992061 99992096 99992264 99992271 99992487 99992546 99992667 99992673 99992814 99992913 99992937 99993002 99993070 99993250 99993425 99993436 99993439 99993512 99993582 99993635 99993983 99994128 99994407 99994416 99994693 99994835 9999
5009 99995213 99995307 99995471 99995671 99995697 99995713 99995716 99995743 99995794 99995861 99996194 99996403 99996621 99996763 99996798 99997354 99997468 99997670 99997722 99997741 99997744 99997841 99998004 99998052 99998397 99998523 99998774 99998854 99998990 99999103 99999181 9
9999231 99999371 99999543 99999682 99999762 99999946

Bubble Sort:
```

//Bubble sort was taking an extreme amount of time and so has not been included in the third output.