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## Problem 4

Create an array of integer numbers, fill the array with random data and print the number of **comparisons, copies, and swaps** made for sorting 10000, 15000, 20000, 25000, 30000, 35000, 40000, 45000 and 50000 items and fill in the table below. Analyze the trend for the three different algorithms.

|  |  |  |  |
| --- | --- | --- | --- |
| **COPIES/ COMPARISONS/ SWAPS** | | | |
|  | **Bubble Sort** | **Selection Sort** | **Insertion Sort** |
| **10000** | **Copies**: 75 533 295  **Comparison**: 49 995 000  **Swaps**: 25 177 765 | **Copies**: 85 430  **Comparison**: 49 995 000  **Swaps**: 10 000 | **Copies**: 25 310 292  **Comparison**: 25 300 293  **Swaps**: 9 999 |
| **15000** | **Copies**: 168 734 586  **Comparison**: 112 492 500  **Swaps**: 56 244 862 | **Copies**: 133 000  **Comparison**: 112 492 500  **Swaps**: 15 000 | **Copies**: 56 742 223  **Comparison**: 56 727 224  **Swaps**: 14 999 |
| **20000** | **Copies**: 300 058 245  **Comparison**: 199 990 000  **Swaps**: 100 019 415 | **Copies**: 180 240  **Comparison**: 199 990 000  **Swaps**: 20 000 | **Copies**: 99 852 521  **Comparison**: 99 832 522  **Swaps**: 19 999 |
| **25000** | **Copies:** 471 539 892  **Comparison:** 312 487 500  **Swap:** 157 179 964 | **Copies:** 228 943  **Comparison:** 312 487 500  **Swap:** 25 000 | **Copies:** 15 476 5895  **Comparison:** 154 740 896  **Swap:** 24 999 |
| **30000** | **Copies:** 674 024 994  **Comparison:** 449 985 000  **Swap:** 224 674 998 | **Copies:** 276 962  **Comparison:** 449 985 000  **Swap:** 30 000 | **Copies:** 224 650 577  **Comparison:** 224 620 578  **Swap:** 29 999 |
| **35000** | **Copies:** 914 021 679  **Comparison:** 612 482 500  **Swap:** 304 673 893 | **Copies:** 323 562  **Comparison:** 612 482 500  **Swap:** 35 000 | **Copies:** 305 435 081  **Comparison:** 305 400 082  **Swap:** 34 999 |
| **40000** | **Copies:** 1 199 537 514  **Comparison:** 799 980 000  **Swap:** 399 845 838 | **Copies:** 372 025  **Comparison:** 799 980 000  **Swap:** 40 000 | **Copies:** 397 922 629  **Comparison:** 397 882 630  **Swap:** 39 999 |
| **45000** | **Copies:** 1 521 406 194  **Comparison:** 1 012 477 500  **Swap:** 507 135 398 | **Copies:** 421 958  **Comparison:** 1 012 477 500  **Swap:** 45 000 | **Copies:** 507 665 852  **Comparison:** 507 620 853  **Swap:** 44 999 |
| **50000** | **Copies:** 1 875 003 078  **Comparison:** 1 249 975 000  **Swap:** 625 001 026 | **Copies:** 471 778  **Comparison:** 1 249 975 000  **Swap:** 50 000 | **Copies:** 624 888 896  **Comparison:** 624 838 897  **Swap:** 49 999 |

**Analyze:**

+ The number of **Comparison** in Bubble Sort and Selection Sort have the same value with the same size in array. However, Insertion Sort is lower than the remaining two sorts, specifically twice as low.

+ The number of **Copies** in Bubble Sort achieve many steps to sort the array, followed by Insertion Sort. Selection Sort just needs some thousand steps to sort.

+ Bubble Sort still achieves many steps to **swap** value. Selection Sort and Insertion Sort is lower than Bubble Sort and have a small step.

* In general, Bubble Sort needs more time to sort. The next is Insertion Sort and Selection Sort take a least time.