Q1

Col-1: quicksort

All elements between the 1st and 11th are less than the 12th element. All elements between the 19th and 24th are greater than the 18th element. Elements between 13th and 17th are in arbitrary order, which have not been seen. This pattern matches quicksort.

Col-2: mergesort(top-down)

The first 12 elements are in ascending order. The rest 12 elements do not have an overall order. But the first half and the second half are both in ascending order. This pattern matches top-down version mergesort.

Col-3: insertion sort

The first 12 elements are in ascending order. The rest elements are in arbitrary order. And it contains elements bigger or less than element in the first half, which means the rest elements have not been seen yet. This pattern matches insertion sort.

Col-4: selection sort

The first 12 elements are in ascending order. All the rest elements are bigger than elements in the first half. This pattern matches selection sort.

Col-5: mergesort(bottom-up)

Elements in the list can be divided into 6 groups. Each group contains 4 adjacent elements. Elements in any groups are in ascending order. This pattern matches bottom-up version mergesort.

Col-6: shell sort

Elements in the list can be divided into 3 groups. Each group contains 8 adjacent elements. There will be a 4-sort pattern in each group. So this is an intermedia

Q2

Average runtime(ms) of these two algorithms under different input size are shown as below. Table 1 shows the average runtime of quicksort using median-of-three and top-down mergesort. Table 2 shows the average runtime of quicksort and mergesort with cut-off. As we can see from tables, quicksort has smaller runtime compared with mergesort under both cases. The runtime will decrease when we use insertion sort when input size is less or equal than 10.

Table 1

| input size | 1m | 1.2m | 1.5m | 1.8m | 2m |
|---|---|---|---|---|---|
| quicksort | 190682 | 230297.7 | 293829 | 363389 | 403425 |
| mergesort | 256968.7 | 315720 | 393797.7 | 475627.7 | 532868.3 |

Table 2

| input size | 1m | 1.2m | 1.5m | 1.8m | 2m |
|---|---|---|---|---|---|
| quicksort | 163495 | 201192 | 254483 | 315735 | 355557 |
| mergesort | 157337.3 | 189412.3 | 260429 | 297666.7 | 328295 |

Q3

Select(9): 9

Rank(15): 24