COMP20003
Algorithms and Data Structures
Why sorting?

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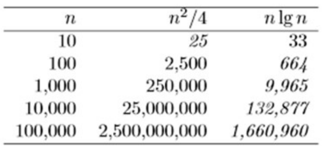
Why is sorting useful to study?

- Sorting has many applications and is used widely
  - In the business world
  - In science
  - and many other disciplines
- Sorting is used within many *other* algorithms
  - very well-studied
  - demonstrates fundamental concepts CS
- Skiena: Chapter 4

Why is sorting useful to study?

- Different algorithms for sorting have different properties, which affect performance



n	$n^2/4$	$n \lg n$
10	25	33
100	2,500	664
1,000	250,000	9,965
10,000	25,000,000	132,877
100,000	2,500,000,000	1,660,960

Table from Skiena, The Algorithm Design Manual

- When data are big, efficiency matters, again!

Selection Sort

```
void selection(item* A, int n)
{
   int i,j,min;
   for( i = 0; i < n-1; i++ )       /* why n-1? */
   {
       min = i;
       for( j = i+1; j < n; j++ )
       {
           if( cmp( A[j], A[min] ) < 0 ) min = j;
       }
        SWAP( A[i], A[min] );
   }
}
```

https://www.jdoodle.com/a/5uP

Selection Sort

- Worst case:
- Best case:
- Average case:

- Usefulness?

Selection Sort

- Is selection sort stable?

Insertion Sort: The idea

```
void insertion(item* A, int n)
{
   int i,j,val;
   for( i=1; i < n; i++ )
   {
       val = A[i]; j=i;
       while( A[j-1] > val )
       {
           A[j] = A[j-1]; j--;
       }
       A[j] = val;
   }
} /* this code doesn't usually work – why not? */
```

https://www.jdoodle.com/a/5uQ

Insertion Sort

- In order to fix it, you need to either:

Insertion Sort

- Worst case:
- Average case:
- Best case:
- Stability?

- Usefulness of insertion sort:

The sound of sorting

https://www.youtube.com/watch?v=t8g-iYGHpEA

Divide and Conquer

- Divide-and-conquer is a common strategy in efficient algorithms

- Divide and Conquer Strategy:
  - Divide instance of problem into smaller instances
  - Solve smaller instances – usually recursively
  - *e.g.* Binary Search

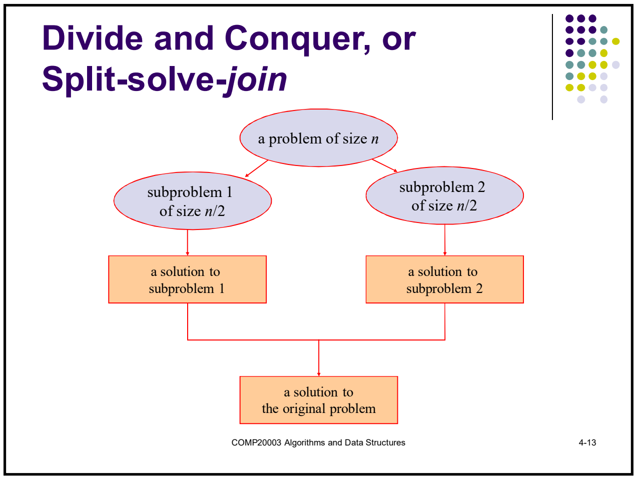
Divide and Conquer

In sorting, the usual strategy is:

- Divide instance of problem into smaller instances

- Solve smaller instances – usually recursively

- Combine smaller solutions



Divide and Conquer, or Split-solve-*join*

a problem of size n

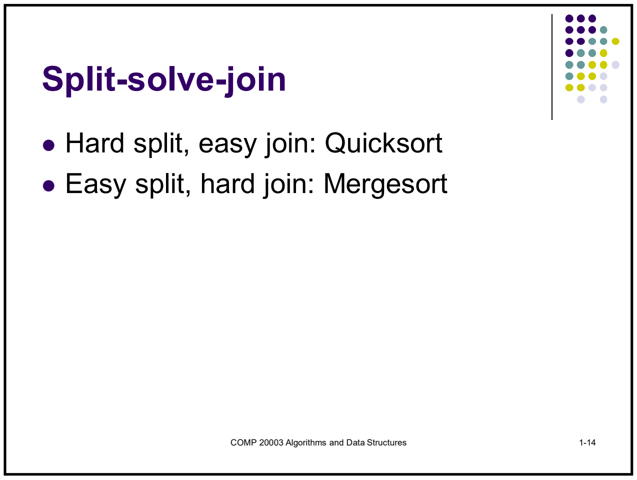
subproblem 1 of size $n/2$

subproblem 2 of size $n/2$

a solution to subproblem 1

a solution to subproblem 2

a solution to the original problem



Split-solve-join

- Hard split, easy join: Quicksort
- Easy split, hard join: Mergesort